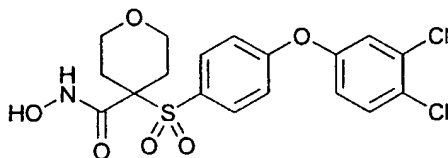


Example 71: Preparation of 4-[[4-(3,4-dichlorophenoxy)-phenyl]sulfonyl]-tetrahydro-N-hydroxy-2H-pyran-4-carboxamide

5



Part A: To a solution of the title compound of Example 55 (3.1 g, 8 mmol) in N,N-dimethylacetamide (20 mL) were added cesium carbonate (8.8 g, 27 mmol) and 3,4-dichlorophenol (2.61 g, 16 mmol). The slurry was stirred at 95 degrees Celsius for forty-one hours. The reaction was concentrated *in vacuo*. The residue was taken up in ethyl acetate, washed with brine, dried over Na<sub>2</sub>SO<sub>4</sub>, filtered, and concentrated *in vacuo*. Chromatography (on silica, ethyl acetate/hexanes) provided the substituted THP-protected hydroxamate as a white foam (4.17 g, 98%). HRMS (ES+) M+ NH<sub>4</sub><sup>+</sup> calculated for C<sub>23</sub>H<sub>25</sub>N<sub>1</sub>O<sub>7</sub> S<sub>1</sub>Cl<sub>2</sub> : 547.11, found 547.10.

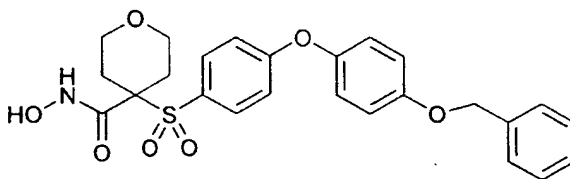
Part B: To a slurry of the THP-protected hydroxamate from part A (3.5 g, 6.6 mmol) in dioxane (20 mL) were added a 4N HCl dioxane solution (20 mL) and methanol (20 mL). After fifteen minutes at ambient temperature the reaction was diluted with ethyl acetate and washed with water, dried over Na<sub>2</sub>SO<sub>4</sub>, filtered, and concentrated *in vacuo*. The residue was slurried in diethyl ether and vacuum

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filtration of the resulting precipitate provided the title compound as a white solid (2.98 g, 100%). HRMS (ES+)  $M + NH_4^+$  calculated for  $C_{18}H_{17}N_1O_6 S_1Cl_2$ : 463.05, found 463.05.

5

Example 72: Preparation of tetrahydro-N-hydroxy-4-  
[[4-[4-[(phenylmethyl)oxy]phenoxy]-  
phenyl]-sulfonyl]-2H-pyran-4-carboxamide



10

Part A: To a solution of the title compound of Example 55 (2.7 g, 7 mmol) in N,N-dimethylacetamide (20 mL) were added cesium carbonate (6.84 g, 21 mmol) and 4-(benzyloxy)phenol (2.8 g, 14 mmol). The slurry was stirred at 95 degrees Celsius for six hours. The reaction was concentrated in vacuo. The residue was taken up in ethyl acetate, washed with brine, dried over  $Na_2SO_4$ , filtered, and concentrated in vacuo. Chromatography (on silica, ethyl acetate/hexanes) provided the substituted THP-protected hydroxamate as a white foam (3.94 g, 99%). HRMS (ES+)  $M + NH_4^+$  calculated for  $C_{30}H_{33}N_1O_8 S_1$ : 585.23, found 585.23.

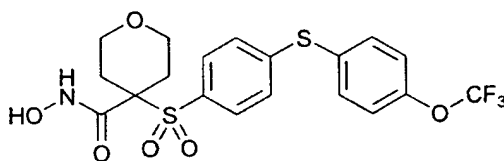
25

Part B: To a slurry of the THP-protected hydroxamate from part A (1.42 g, 2.5 mmol) in dioxane (6.3 mL) were added a 4N HCl dioxane solution (6.3 mL) and methanol (6.3 mL). After fifteen minutes at

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ambient temperature the reaction was diluted with ethyl acetate and washed with water, dried over  $\text{Na}_2\text{SO}_4$ , filtered, and concentrated *in vacuo*. The product was recrystallized (acetone/hexanes) to give  
5 the title compound as a white solid (0.56 g, 46%).  
HRMS (ES+)  $\text{MH}^+$  calculated for  $\text{C}_{25}\text{H}_{25}\text{N}_1\text{O}_7$ ,  $S_1$ : 484.14, found 484.14.

Example 73: Preparation of tetrahydro-N-hydroxy-4-  
10 [[4-[4-(trifluoromethoxy)phenylthio]-  
phenyl]-sulfonyl]-2H-pyran-4-carboxamide



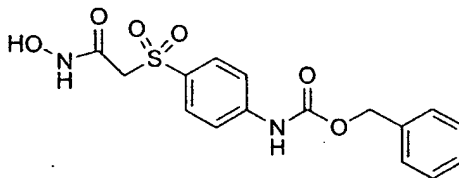
15 Part A: To a solution of the title compound of Example 55 (3.1 g, 8 mmol) in N,N-dimethylformamide (20 mL) were added potassium carbonate (2.21 g, 16mmol) and p-(trifluoromethoxy)benzenethiol (2.33 g, 12 mmol).  
20 The slurry was stirred at 70 degrees Celsius for two hours. The reaction was concentrated *in vacuo*. The residue was taken up in ethyl acetate, washed with brine, dried over  $\text{Na}_2\text{SO}_4$ , filtered, and concentrated *in vacuo*. Chromatography (on silica, ethyl  
25 acetate/hexanes) provided the substituted THP-protected hydroxamate as a white solid (4.4 g, 98%).  
HRMS (ES+)  $\text{M}+\text{NH}_4^+$  calculated for  $\text{C}_{24}\text{H}_{26}\text{N}_1\text{O}_7\text{S}_2\text{F}_3$ : 579.14, found 579.14.

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Part B: To a slurry of the THP-protected hydroxamate from part A (4.15 g, 7.4 mmol) in dioxane (20 mL) were added a 4N HCl dioxane solution (20 mL) and methanol (20 mL). After fifteen minutes at ambient temperature the reaction was diluted with ethyl acetate and washed with water, dried over  $\text{Na}_2\text{SO}_4$ , filtered, and concentrated in vacuo. The product was recrystallized (acetone/hexanes) to give the title compound as a white solid (3.0 g, 85%).

HRMS (ES+)  $\text{M}+\text{NH}_4^+$  calculated for  $\text{C}_{19}\text{H}_{18}\text{N}_1\text{O}_6 \text{ S}_2\text{F}_3$ : 495.09, found 495.09.

Example 74: Preparation of phenylmethyl-[4-[[2-(hydroxyamino)-2-oxoethyl]-sulfonyl]phenyl]carbamate



Part A: To a suspension of 2-(4-aminophenylthio) acetic acid (20.0 g, 0.11 mol) in methanol (100 mL), cooled to zero degrees Celsius, was slowly added thionyl chloride (24.0 mL, 0.33 mol). Additional methanol (100 mL) was added and the cooling bath was removed. The resulting mixture was heated at reflux for 2 hours. The reaction mixture was then cooled to ambient temperature and concentrated in vacuo. The residue was dissolved in  $\text{H}_2\text{O}$  and neutralized with saturated  $\text{NaHCO}_3$ . The aqueous reaction mixture was extracted with ethyl



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acetate. The organic layer was washed with saturated NaCl and dried over  $\text{Na}_2\text{SO}_4$ . Concentration *in vacuo* provided the methyl ester sulfide as a dark purple oil (22.75 g, quantitative yield).

5           Part B: To a solution of the methyl ester sulfide of part A (10.0 g, 50.7 mmol) in dichloromethane (100 mL) was added *N*-methyldmorpholine (11.2 mL, 101.4 mmol), followed by *N*-(benzyloxycarbonyloxy)succinimide (12.6 g, 50.7 mmol). The resulting mixture was stirred at ambient temperature overnight (about 18 hours) and then concentrated *in vacuo*. The residue was dissolved in ethyl acetate and then washed with  $\text{H}_2\text{O}$ , 5%  $\text{KHSO}_4$ , saturated NaCl and dried over  $\text{Na}_2\text{SO}_4$ . Concentration  
10           *in vacuo* provided the benzyloxy carbamate sulfide as a dark oil (16.2 g, 96%).

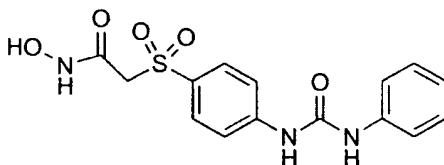
          Part C: To a solution of the benzyloxy carbamate sulfide of part B (16.2 g, 48.7 mmol) in tetrahydrofuran (100 mL) and  $\text{H}_2\text{O}$  (10 mL) was added  
20   Oxone® (90.0 g, 146.4 mmol), and the resulting mixture was stirred at ambient temperature for 16 hours. The reaction mixture was then filtered and the filtrate was concentrated *in vacuo*. The residue was dissolved in ethyl acetate, washed with  $\text{H}_2\text{O}$ ,  
25   saturated NaCl and dried over  $\text{Na}_2\text{SO}_4$ . Concentration *in vacuo* provided the benzyloxy carbamate sulfone as a tan solid (15.6 g, 88%).

          Part D: To a solution of the benzyloxy carbamate sulfone of part C (0.25 g, 0.69 mmol) in  
30   tetrahydrofuran (3 mL) was added 50% aqueous hydroxylamine (1.5 mL). The resulting mixture was

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stirred at ambient temperature for 24 hours. The mixture was then diluted with ethyl acetate (30 mL), washed with H<sub>2</sub>O, saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Concentration *in vacuo* followed by washing with hot  
5 diethyl ether provided the title compound as a pale pink solid (0.20 g, 80%). MS MH<sup>+</sup> calculated for C<sub>16</sub>H<sub>17</sub>O<sub>6</sub>N<sub>2</sub>S: 365, found 365.

10 Example 75: Preparation of N-hydroxy-2-[[4-  
[[ (phenylamino) carbonyl] amino] -  
phenyl] sulfonyl] acetamide



15 Part A: Hydrogen gas was bubbled into a suspension of the benzyloxy carbamate sulfone of part C, Example 74 (13.4 g, 36.8 mmol) and 4% Pd/C in tetrahydrofuran (100 mL). After the uptake of H<sub>2</sub> ceased the mixture was purged with N<sub>2</sub> and then  
20 filtered through a pad of Celite® washing with tetrahydrofuran. The filtrate was concentrated *in vacuo* to give the aniline as a brown solid (8.1 g, 96%).

25 Part B: To a suspension of the aniline of part A (0.50 g, 2.2 mmol) in dichloromethane (4 mL) was added phenyl isocyanate (0.36 mL, 3.3 mmol). The mixture was stirred at ambient temperature overnight (about 18 hours) and then diluted with

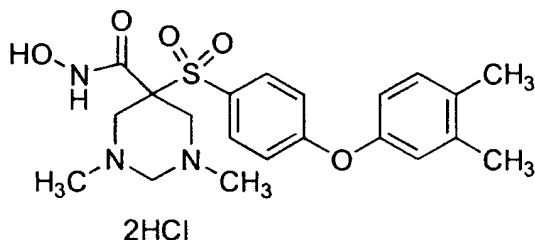
-433-

dichloromethane (50 mL). The mixture was then washed with H<sub>2</sub>O, saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>.

Chromatography (on silica, ethyl acetate/hexane) provided the urea as a white solid (0.59 g, 78%).

5                    Part C: To a solution of the urea of part B (0.32 g, 0.92 mmol) in tetrahydrofuran (3 mL) was added 50% aqueous hydroxylamine (1.5 mL). The resulting mixture was stirred at ambient temperature for 24 hours. The mixture was then diluted with  
10 ethyl acetate (30 mL), washed with H<sub>2</sub>O, saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Concentration in vacuo, followed by washing with hot diethyl ether provided the title compound as a pale pink solid (0.24 g, 76%). MS MH<sup>+</sup> calculated for C<sub>15</sub>H<sub>16</sub>O<sub>3</sub>N<sub>3</sub>S: 350, found  
15 350.

Example 78: Preparation of 5-[4-(3,4-dimethylphenoxy)phenyl]sulfonyl-N<sup>5</sup>-hydroxy-1,3-dimethylhexahydro-5-pyrimidinecarboxamide, dihydrochloride  
20 pyrimidinecarboxamide, dihydrochloride



Part A: To a solution of part B, Example  
25 55 (2.00 g, 8.61 mmol) and 1,3,5-trimethylhexahydro-1,3,5-triazine (1.21 mL, 8.61 mmol) in benzene (20 mL) was slowly added trifluoroacetic acid (0.66 mL,

8.61 mmol). The resulting mixture was heated at reflux for 1 hour and then cooled to ambient temperature. The mixture was then extracted with 2N HCl. The aqueous layer was neutralized with  
5 saturated NaHCO<sub>3</sub> and then extracted with diethyl ether. The organic layers were washed with saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Concentration *in vacuo* provided the tetrahydropyrimidine as a clear oil (2.31 g, 81%).

10 Part B: To a solution of the tetrahydropyrimidine of part A (1.26 g, 3.81 mmol) in *N,N*-dimethylformamide (5.0 mL) were added 3,4-dimethylphenol (0.559 g, 4.58 mmol) and Cs<sub>2</sub>CO<sub>3</sub> (3.72 g, 11.43 mmol). The resulting mixture was heated at  
15 90 degrees Celsius for 16 hours. After cooling to ambient temperature, the reaction was diluted with H<sub>2</sub>O and extracted with ethyl acetate. The organic layers were washed with saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Chromatography (on silica, ethyl acetate) gave the  
20 biaryl ether as a pale amber oil (1.40 g, 85%).

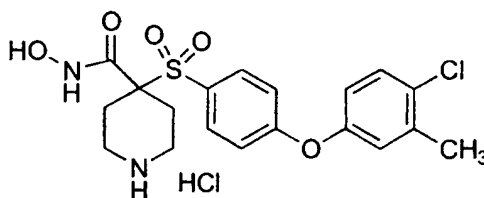
Part C: To a solution of the biaryl ether of part B (0.936 g, 2.16 mmol) in tetrahydrofuran (5.0 mL) was added potassium trimethylsilanolate (0.360 g, 2.81 mmol). The resulting mixture was  
25 stirred at ambient temperature for 48 hours and then the solvent was removed. The resulting residue was dissolved in dichloromethane (5.0 mL) then, *N*-methylemorpholine (0.712 mL, 6.48 mmol) and *O*-tetrahydro-2H-pyran-2-yl-hydroxylamine (0.278 g, 2.38  
30 mmol) were added. After stirring at ambient temperature for 10 minutes, PyBroP® (1.21 g, 2.59

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mmol) was added. The resulting mixture was stirred at ambient temperature overnight (about 18 hours), then diluted with dichloromethane (50 mL) and washed with H<sub>2</sub>O. The organic layer was removed and washed  
5 with saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Chromatography (on silica, ethyl acetate) provided the hydroxamate as a white solid (0.970 g, 87%).

Part F: To a suspension of the hydroxamate of part E (0.667 g, 1.29 mmol) in dioxane (3.0 mL)  
10 and methanol (1.0 mL) was added a solution of 4N HCl in dioxane (3.22 mL, 12.9 mmol). After stirring at ambient temperature for 30 minutes, the reaction mixture was concentrated *in vacuo*. Reverse phase chromatography (on silica, acetonitrile/H<sub>2</sub>O/  
15 trifluoroacetic acid) provided the title compound as a white solid (0.379 g, 58%). MS MH<sup>+</sup> calculated for C<sub>21</sub>H<sub>28</sub>O<sub>5</sub>N<sub>3</sub>S: 434, found 434.

Example 79: Preparation of 4-[[4-(4-chloro-3-  
20 methylphenoxy)phenyl]sulfonyl]-N-hydroxy-4-piperidinecarboxamide,  
monohydrochloride



25

Part A: To a suspension of isonipectic acid (50.0 g, 0.39 mol) in methanol (300 mL) cooled to zero degrees Celsius was slowly added dropwise

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thionyl chloride (85.0 mL, 1.16 mol). Once the addition was complete the cooling bath was removed and the mixture was heated at reflux for 2 hours. After cooling to ambient temperature the reaction mixture was concentrated *in vacuo*. The resulting solids were suspended in ethyl acetate and then washed with saturated  $\text{NaHCO}_3$ . The aqueous layer was concentrated *in vacuo* and the resulting solids were dissolved in hot ethyl acetate and decanted from the salts. The organic layers were then concentrated *in vacuo* to give the methyl ester as a white solid (55.4 g, quantitative yield).

Part B: To a solution of di-tert-butyl dicarbonate (15.3 g, 70.0 mmol) in tetrahydrofuran (100 mL) was added the methyl ester of part A (10.0 g, 70.0 mmol). The resulting mixture was stirred at ambient temperature overnight (about 18 hours) and then concentrated *in vacuo*. Chromatography (on silica, ethyl acetate/hexane) provided the Boc-piperidine methyl ester as a pale yellow oil (10.1 g, 59%).

Part C: To a solution of the Boc-piperidine methyl ester of part B (23.31 g, 0.096 mol) in tetrahydrofuran (500 mL), cooled to minus 40 degrees Celsius, was slowly added lithium diisopropylamide (57.5 mL, 2.0 M in THF, 0.115 mol). The resulting mixture was stirred at minus 40 degrees Celsius for 1 hour and then at zero degrees Celsius for 30 minutes. The mixture was then recooled to minus 40 degrees Celsius and a solution of the disulfide from Part A, Example 6 (24.37 g, 0.096 mol)

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in tetrahydrofuran (60 mL) was slowly added. The resulting mixture was slowly warmed to ambient temperature overnight (about 18 hours) and then H<sub>2</sub>O (200 mL) was added. The mixture was then

5 concentrated *in vacuo* and the aqueous layer was extracted with ethyl acetate. The organic layers were washed with 0.5 M NaOH, H<sub>2</sub>O, saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Chromatography (on silica, ethyl acetate/hexane) gave the sulfide as an amber oil

10 (28.1 g, 79%).

Part D: To a solution of the sulfide of part C (28.2 g, 0.076 mol) in dichloromethane (250 mL), cooled to zero degrees Celsius, was added m-chloroperoxy-benzoic acid (48 g, 0.152 mol). The

15 resulting mixture was stirred at zero degrees Celsius for 1 hour, and then at ambient temperature for 2.5 hours. The mixture was then diluted with H<sub>2</sub>O and 10% NH<sub>4</sub>OH. The organic layer was washed with 10% NH<sub>4</sub>OH, H<sub>2</sub>O and dried over Na<sub>2</sub>SO<sub>4</sub>. Chromatography (on silica,

20 ethyl acetate/hexane) provided the sulfone as a white solid (24.7 g, 81%).

Part E: To a solution of the sulfone of part D (3.00 g, 7.47 mmol) in *N,N*-dimethylformamide (15 mL) were added 4-chloro-3-methylphenol (1.28 g,

25 8.96 mmol) and Cs<sub>2</sub>CO<sub>3</sub> (7.30 g, 22.42 mmol). The resulting mixture was heated at 80 degrees Celsius for 8 hours. The mixture was then concentrated *in vacuo*, and the residue was partitioned between H<sub>2</sub>O and ethyl acetate. The organic layer was washed with

30 saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Chromatography

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(on silica, ethyl acetate/hexane) gave the biaryl ether as a clear oil (3.26 g, 83%).

Part F: To a solution of the biaryl ether of part E (3.17 g, 6.05 mmol) in tetrahydrofuran (30 mL) was added potassium trimethylsilanolate (1.01 g, 7.87 mmol). The resulting mixture was stirred at ambient temperature for 20 hours. Additional tetrahydrofuran (40 mL) was added and the mixture was stirred at ambient temperature for 36 hours.

10 Additional potassium trimethylsilanolate (0.233 g, 1.82 mmol) was added and the mixture was stirred at ambient temperature for 23 hours. The tetrahydrofuran was removed and the resulting residue was suspended in dichloromethane (30 mL). To the

15 suspension was added *N*-methylmorpholine (2.00 mL, 18.15 mmol) and *O*-tetrahydro-2H-pyran-2-yl-hydroxylamine (0.780 g, 6.66 mmol) followed by PyBroP® (3.38 g, 7.26 mmol). The mixture was stirred at ambient temperature for 24 hours and then

20 concentrated in vacuo. The residue was partitioned between H<sub>2</sub>O and ethyl acetate. The organic layer was washed with H<sub>2</sub>O, saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Chromatography (on silica, ethyl acetate/hexane) provided the hydroxamate as an off-white foam (2.98

25 g, 81%).

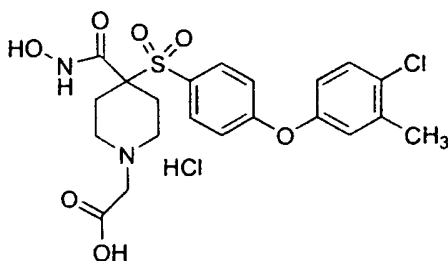
Part G: To a solution of the hydroxamate of part F (2.98 g, 4.89 mmol) in dioxane (14 mL) and methanol (6 mL) was added a solution of 4N HCl in dioxane (10 mL). The resulting mixture was stirred

30 at ambient temperature for 3.5 hours, then diethyl ether (40 mL) was added and the precipitate was



collected by filtration to provide the title compound as a light pink solid (2.00 g, 88%). MS MH<sup>+</sup> calculated for C<sub>19</sub>H<sub>22</sub>O<sub>5</sub>N<sub>2</sub>ClS: 425, found 425.

- 5 Example 80: Preparation of 4-[[4-(4-chloro-3-methylphenoxy)phenyl]sulfonyl]-4-(hydroxyamino)carbonyl]-1-  
piperidineacetic acid, monohydrochloride



10

- Part A: To a suspension of the title compound of Example 80 (0.250 g, 0.542 mmol) in acetonitrile (4.0 mL) were added tert-butylbromoacetate (0.088 mL, 0.542 mmol) and K<sub>2</sub>CO<sub>3</sub> (0.150 g, 1.08 mmol). The resulting mixture was stirred at ambient temperature for 18 hours, then filtered through a pad of Celite®, washing with ethyl acetate. The filtrate was then concentrated in vacuo. Reverse phase chromatography (on silica, acetonitrile/H<sub>2</sub>O/trifluoroacetic acid) provided the tert-butyl ester as a white solid (0.156 g, 53%).

- Part B: The tert-butyl ester of part A (0.156 g, 0.289 mmol) was treated with a solution of 4N HCl in dioxane (1.5 mL) and the resulting mixture was stirred at ambient temperature for 3.5 hours at which time additional dioxane (2 mL) was added.

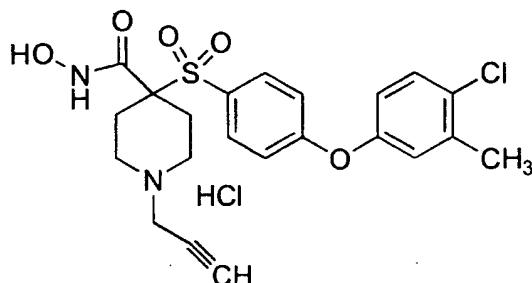
-440-

After stirring at ambient temperature for 8 hours the reaction mixture was concentrated *in vacuo*. The residue was treated again with a solution of 4N HCl in dioxane (1.5 mL) at ambient temperature for 4  
5 hours. Diethyl ether was added to the reaction mixture and the precipitate was collected by filtration to give the title compound as an off-white solid (0.111 g, 74%). MS  $MH^+$  calculated for  $C_{21}H_{24}O_7N_2SCl$ : 483, found 483.

10

Example 81: Preparation of 4-[[4-(4-chloro-3-methylphenoxy)phenyl]sulfonyl]-N-hydroxy-1-(2-propynyl)-4-  
piperidinecarboxamide, monohydrochloride

15



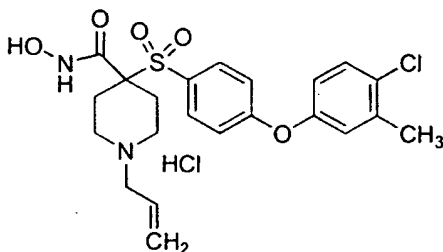
Part A: To a suspension of the title compound of Example 79 (0.500 g, 1.08 mmol) in  
20 acetonitrile (8.0 mL) were added propargyl bromide (0.126 mL, 80% solution in toluene, 1.13 mmol) and  $K_2CO_3$  (0.300 g, 2.17 mmol). The resulting mixture was stirred at ambient temperature for 24 hours, then filtered through a pad of Celite®, washing with  
25 methanol and the filtrate was then concentrated *in vacuo*. Chromatography (on silica, ethyl acetate)

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provided the *N*-propargyl hydroxamate as a tan solid (0.200 g, 40%).

Part B: To a solution of the *N*-propargyl hydroxamate of part A (0.200 g, 0.432 mmol) in  
5 acetonitrile (3.0 mL) and H<sub>2</sub>O (0.5 mL) was added concentrated HCl (0.05 mL). The resulting mixture was stirred at ambient temperature for 5 minutes and the concentrated in vacuo to provide the title compound as a pink solid (0.200 g, 93%). MS MH<sup>+</sup>  
10 calculated for C<sub>22</sub>H<sub>24</sub>O<sub>3</sub>N<sub>2</sub>SCl: 463, found 463.

Example 82: Preparation of 4-[[4-(4-chloro-3-methylphenoxy)phenyl]sulfonyl]-*N*-hydroxy-1-(2-propenyl)-4-  
15 piperidinecarboxamide, monohydrochloride



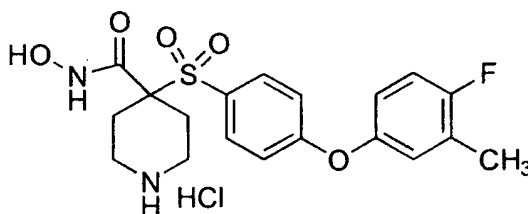
Part A: To a suspension of the title  
20 compound of Example 79 (0.500 g, 1.08 mmol) in acetonitrile (8.0 mL) were added allyl bromide (0.093 mL, 1.08 mmol) and K<sub>2</sub>CO<sub>3</sub> (0.300 g, 2.17 mmol). The resulting mixture was stirred at ambient temperature for 22 hours. Additional allyl bromide (0.054 mL, 1M  
25 in acetonitrile, 0.054 mmol) was added and stirring was continued at ambient temperature for 6 hours. The resulting mixture was filtered through a pad of

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Celite®, washing with ethyl acetate and the filtrate was concentrated in vacuo. Chromatography (on silica, methanol/ethyl acetate) provided the *N*-allyl hydroxamate as an off-white solid (0.080 g, 15%).

- 5                   Part B: To a solution of the *N*-allyl hydroxamate of part A (0.080 g, 0.172 mmol) in acetonitrile (3.0 mL) and H<sub>2</sub>O (1.0 mL) was added concentrated HCl (0.05 mL). The resulting mixture was stirred at ambient temperature for ten minutes  
10 and then concentrated in vacuo to provide the title compound as a white solid (0.100 g, quantitative yield). MS MH<sup>+</sup> calculated for C<sub>22</sub>H<sub>26</sub>O<sub>5</sub>N<sub>2</sub>SCl: 465, found 465.

- 15   Example 83: Preparation of 4-[[4-(4-fluoro-3-methylphenoxy)phenyl]sulfonyl]-*N*-hydroxy-4-piperidine carboxamide,  
monohydrochloride



20

- Part A: To a solution of the sulfone of part D, Example 79 (5.00 g, 12.45 mmol) in tetrahydrofuran (100 mL) was added potassium  
25 trimethylsilanolate (4.79 g, 37.36 mmol). The resulting mixture was stirred at ambient temperature for 1.5 hours, diluted with H<sub>2</sub>O and diethyl ether (100

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mL). The aqueous layer was extracted with diethyl ether and the combined organic layers were washed with H<sub>2</sub>O. The aqueous layers were combined and acidified with 2N HCl (pH=2) and then extracted with ethyl acetate. The combined organic layers were washed with saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub> to provide the acid as an off-white solid (4.61 g, 96%).

Part B: To a suspension of the acid of part A (0.830 g, 2.14 mmol) in dichloromethane (10 mL) was added *N*-methylemorpholine (0.706 mL, 6.42 mmol) and *O*-tetrahydro-2H-pyran-2-yl-hydroxylamine (0.276 g, 2.35 mmol). After stirring at ambient temperature for 5 minutes, PyBroP® (1.20 g, 2.57 mmol) was added and the resulting mixture was stirred at ambient temperature for 19 hours. The mixture was concentrated *in vacuo* and the residue was partitioned between H<sub>2</sub>O and ethyl acetate. The aqueous layer was further extracted with ethyl acetate and the combined organic layers were washed with saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Chromatography (on silica, ethyl acetate/hexane) provided the *p*-fluorosulfone as a white crystalline solid (0.993 g, 95%).

Part C: To a solution of the *p*-fluorosulfone of part B (0.485 g, 0.996 mmol) in *N,N*-dimethylformamide (5 mL) were added 4-fluoro-3-methylphenol (0.133 mL, 1.20 mmol) and Cs<sub>2</sub>CO<sub>3</sub> (0.973 g, 2.99 mmol). The resulting mixture was heated at 60 degrees Celsius for 17 hours. Additional 4-fluoro-3-methylphenol (0.055 mL, 0.498 mmol) was added and the temperature of the reaction mixture was

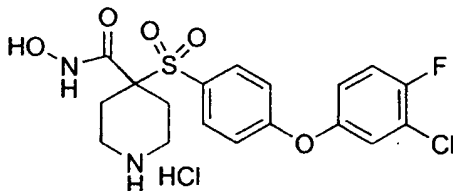
-444-

increased to 80 degrees Celsius for 4 hours and then to 100 degrees Celsius for 3 hours. Additional 4-fluoro-3-methylphenol (0.133 mL, 1.20 mmol) was added and the reaction mixture was heated at 100 degrees Celsius for 7.5 hours. Additional  $\text{Cs}_2\text{CO}_3$  was added and heating continued at 100 degrees Celsius for 17 hours. The reaction was cooled to ambient temperature and then concentrated *in vacuo*. The residue was partitioned between  $\text{H}_2\text{O}$  and ethyl acetate. The organic layer was washed with saturated NaCl and dried over  $\text{Na}_2\text{SO}_4$ . Chromatography (on silica, ethyl acetate/hexane) provided the protected hydroxamate as an off-white solid (0.490 g, 83%).

Part D: To a solution of the protected hydroxamate of part C (0.479 g, 0.808 mmol) in dioxane (3 mL) and methanol (1 mL) was added a solution of 4N HCl in dioxane (2.02 mL, 8.08 mmol). The resulting mixture was stirred at ambient temperature for 1.5 hours. Diethyl ether (5 mL) was added and the precipitate was collected by filtration to give the title compound as an off-white solid (0.323 g, 90%). MS  $\text{MH}^+$  calculated for  $\text{C}_{19}\text{H}_{22}\text{O}_5\text{N}_2\text{SF}$ : 409, found 409.

Example 84: Preparation of 4-[[4-(3-chloro-4-fluorophenoxy)phenyl]sulfonyl]-N-hydroxy-4-piperidine carboxamide,  
monohydrochloride

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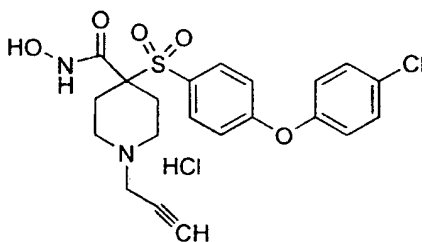
Part A: To a solution of the *p*-fluorosulfone of Part B, Example 83 (0.485 g, 0.996 mmol) in *N,N*-dimethylformamide (5.0 mL) were added 4-fluoro-3-chlorophenol (0.176 g, 1.20 mmol) and Cs<sub>2</sub>CO<sub>3</sub> (0.973 g, 2.99 mmol). The resulting mixture was heated at 60 degrees Celsius for 17 hours, then additional 4-fluoro-3-chlorophenol (0.073 g, 0.498 mmol) was added and the reaction mixture was heated at 80 degrees Celsius for 24 hours then increased to 90degrees Celsius. After heating 90 degrees Celsius for 7 hours additional 4-fluoro-3-chlorophenol (0.176 g, 1.20 mmol) was added and heating was contiuned at 90 degrees Celsius for 7.5 hours. Additional Cs<sub>2</sub>CO<sub>3</sub> (0.973 g, 2.99 mmol) was added and the mixture was heated at 90 degrees Celsius for 24 hours. After cooling to ambient temperature, the reaction mixture was concentrated in vacuo. The residue was partitioned between H<sub>2</sub>O and ethyl acetate. The organic layer was washed with saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Chromatography (on silica, ethyl acetate/hexane) provided the protected hydroxamate as an off-white solid (0.550 g, 90%).

Part B: To a solution of the protected hydroxamate of part A (0.530 g, 0.864 mmol) in dioxane (3 mL) and methanol (1 mL) was added a solution of 4N HCl in dioxane (2.00 mL, 8.00 mmol).

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The resulting mixture was stirred at ambient temperature for 1.5 hours. Diethyl ether (5 mL) was added and the precipitate was collected by filtration to give the title compound as an off-white solid (0.377 g, 94%). MS  $MH^+$  calculated for  $C_{19}H_{19}O_5N_2SFCl$ : 429, found 429.

Example 85: Preparation of 4-[[4-(4-chlorophenoxy)-phenyl]sulfonyl]-N-hydroxy-1-(2-propynyl)-4-piperidinecarboxamide, monohydrochloride



Part A: To a solution of sulfone of part D, Example 79 (4.53 g, 11.28 mmol) in *N,N*-dimethylformamide (20 mL) were added 4-chlorophenol (4.41 g, 13.54 mmol) and Cs<sub>2</sub>CO<sub>3</sub> (11.03 g, 33.85 mmol). The resulting mixture was heated at 90 degrees Celsius for 5 hours. After cooling to ambient temperature, the reaction mixture was concentrated in vacuo. The residue was partitioned between H<sub>2</sub>O and ethyl acetate. The organic layer was washed with saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Chromatography (on silica, ethyl acetate/hexane) provided the biaryl ether as a white solid (4.60 g, 78%).



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Part B: To a solution of the biaryl ether of part A (4.57 g, 8.96 mmol) in dioxane (10 mL) was added a solution of 4N HCl in dioxane (10 mL). The resulting mixture was stirred at ambient temperature for 2.5 hours and then additional dioxane (10 mL) was added. After stirring at ambient temperature for 1.5 hours the mixture was concentrated in vacuo. The resulting solid was suspended in dioxane (20 mL) and retreated with a solution of 4N HCl in dioxane (10 mL). The mixture was stirred at ambient temperature for 1 hour, methanol (1 mL) was added and stirring was continued at ambient temperature. After 1 hour, the mixture was concentrated in vacuo to give the amine as a white solid (4.09 g, quantitative yield).

Part C: To a suspension of the amine of part B (4.00 g, 8.96 mmol) in acetonitrile (20 mL) were added propargyl bromide (1.05 mL, 80% solution in toluene, 9.41 mmol) and  $K_2CO_3$  (2.60 g, 18.82 mmol). The resulting mixture was stirred at ambient temperature for 18 hours, filtered through a pad of Celite®, washing with ethyl acetate, and then the filtrate was concentrated in vacuo to provide the N-propargyl amine as a sticky foam (4.14 g, quantitative yield).

Part D: To a suspension of the N-propargyl amine of part C (4.14 g, 8.96 mmol) in tetrahydrofuran (20 mL) was added potassium trimethylsilanolate (1.26 g, 9.86 mmol). The resulting mixture was stirred at ambient temperature for 17 hours and additional tetrahydrofuran (5 mL) and potassium trimethylsilanolate (0.350 g, 2.73

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mmol) were added. After stirring at ambient temperature for 4 hours, additional tetrahydrofuran (5 mL) was added and stirring was continued at ambient temperature for 24 hours. Additional  
5 potassium trimethylsilanolate (0.115 g, 0.896 mmol) was added and the mixture was stirred at ambient temperature for 24 hours, at which time, additional potassium trimethylsilanolate was added and the resulting mixture was stirred at ambient temperature  
10 for another 24 hours. The tetrahydrofuran was removed and the residue was suspended in dichloromethane (20 mL).

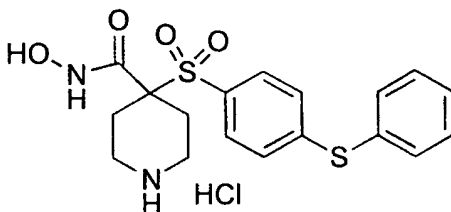
To the dichloromethane suspension were added *N*-methylemorpholine (2.96 mL, 26.9 mmol) and *O*-  
15 tetrahydro-2H-pyran-2-yl-hydroxylamine (1.15 g, 9.86 mmol), followed by PyBroP® (5.01 g, 10.75 mmol). The resulting mixture was stirred at ambient temperature overnight and then concentrated *in vacuo*. The residue was partitioned between H<sub>2</sub>O and ethyl acetate.  
20 The organic layer was washed with saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Chromatography (on silica, ethyl acetate/hexane) provided the protected hydroxamate as an off-white foam (3.29 g, 69%).

Part E: To a solution of the protected  
25 hydroxamate of part D (3.27 g, 6.13 mmol) in dioxane (21 mL) and methanol (7 mL) was added a solution of 4*N* HCl in dioxane (10 mL). The resulting mixture was stirred at ambient temperature for 4 hours and then diethyl ether (75 mL) was added. The solids were  
30 collected by filtration, washing with diethyl ether, to give the title compound as an off-white solid

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(2.95 g, 99%). MS  $MH^+$  calculated for  $C_{21}H_{22}O_5N_2SCl$ :  
449, found 449.

Example 86: Preparation of 4-[[4-(phenylthio)-  
5 phenyl]-sulfonyl]-N-hydroxy-4-  
piperidine-carboxamide,  
monohydrochloride



10

Part A: To a solution of the sulfone of  
part D, Example 79 (0.500 g, 1.25 mmol) in *N,N*-  
dimethylformamide (3.0 mL) were added thiophenol  
(0.154 mL, 1.50 mmol) and  $K_2CO_3$  (0.518 g, 3.75 mmol).  
15 The resulting mixture was stirred at ambient  
temperature for 24 hours and then concentrated *in*  
*vacuo*. The residue was partitioned between  $H_2O$  and  
ethyl acetate. The organic layers were washed with  
saturated NaCl and dried over  $Na_2SO_4$ . Chromatography  
20 (on silica, ethyl acetate/hexane) provided the biaryl  
thioether as a clear sticky oil (0.480 g, 78%).

Part B: To a solution of the biaryl  
thioether of part A (2.01 g, 4.09 mmol) in  
tetrahydrofuran (40 mL) was added potassium  
25 trimethylsilanolate (0.682 g, 5.31 mmol). The  
resulting mixture was stirred at ambient temperature  
for 23 hours and then concentrated *in vacuo*. The

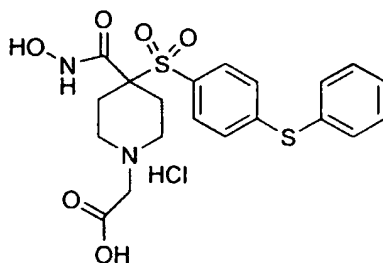
-450-

residue was then suspended in dichloromethane (20 mL) then *N*-methyilmorpholine (1.35 mL, 12.27 mmol) and 50% aqueous hydroxylamine (0.265 mL, 4.50 mmol) were added, followed by PyBroP® (2.29 g, 4.91 mmol). The  
5 resulting mixture was stirred at ambient temperature for 16 hours and then concentrated *in vacuo*. The residue was partitioned between ethyl acetate and H<sub>2</sub>O. The organic layer was washed with saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. A portion of the sample was  
10 subjected to reverse phase chromatography (on silica, acetonitrile/H<sub>2</sub>O/trifluoroacetic acid) to give the hydroxamate as an off-white solid (0.190 g).

Part C: To a solution of the hydroxamate of part B (0.181 g, 0.367 mmol) in dioxane (5 mL) and  
15 methanol (1 mL) was added a solution of 4*N* HCl in dioxane (3 mL). The resulting mixture was stirred at ambient temperature for 3 hours and then concentrated *in vacuo* to give the title compound as an off-white solid (0.170 g, quantitative yield). MS MH<sup>+</sup>  
20 calculated for C<sub>18</sub>H<sub>21</sub>O<sub>4</sub>N<sub>2</sub>S<sub>2</sub>: 393, found 393.

Example 87: Preparation of 4-[(hydroxyamino)-  
carbonyl]-4-[[4-(phenylthio)phenyl]-  
sulfonyl]-1-piperidineacetic acid,  
25 monohydrochloride

-451-



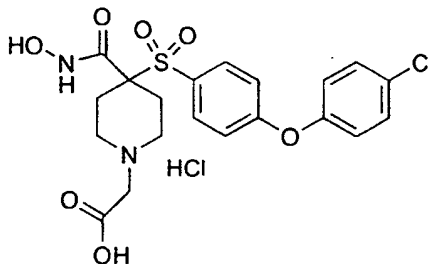
Part A: To a solution of the compound of Example 86 (0.322 g, 0.751 mmol) in acetonitrile (4.0 mL) were added tert-butylbromoacetate (0.121 mL, 0.751 mmol) and  $K_2CO_3$  (0.207 g, 1.50 mmol). The resulting mixture was stirred at ambient temperature for 18 hours, filtered through a pad of Celite®, washing with ethyl acetate, and the filtrate was concentrated *in vacuo*. Reverse phase chromatography (on silica, acetonitrile /H<sub>2</sub>O/trifluoroacetic acid) provided the tert-butyl ester as an off-white solid (0.150 g, 40%).

Part B: The tert-butyl ester of part A (0.145 g, 0.286 mmol) was treated with a solution of 4N HCl in dioxane (3.0 mL). The resulting mixture was stirred at ambient temperature for 7 hours, diethyl ether was added and the precipitate was collected by filtration. Reverse phase chromatography (on silica, acetonitrile /H<sub>2</sub>O/HCl) provided the title compound as an off-white solid (0.060 g, 43%). MS  $MH^+$  calculated for  $C_{20}H_{23}O_6N_2S_2$ : 451, found 451.

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Example 88: Preparation of 4-[[4-(4-chlorophenoxy)-phenyl]sulfonyl]-4-[(hydroxyamino)-carbonyl]-1-piperidineacetic acid, monohydrochloride

5



Part A: To a suspension of 4-bromopiperidine hydrobromide (40.0 g, 0.16 mol) in tetrahydrofuran (200 mL) was slowly added triethylamine (45.4 mL, 0.33 mol), followed by di-tert-butyl dicarbonate (37.4 g, 0.17 mol), which was added in several portions. The resulting mixture was stirred at ambient temperature for 17 hours then filtered and concentrated in vacuo. The solids were washed with hexanes and then collected by filtration to give the Boc-piperidine compound as an amber oil (45.8 g, >100%).

Part B: To a solution of 4-fluorophenol (25.0 g, 0.20 mol) in acetone (150 mL), degassed with N<sub>2</sub>, was added Cs<sub>2</sub>CO<sub>3</sub> (79.7 g, 0.25 mol). After degassing the resulting mixture with N<sub>2</sub> for 5 minutes, the Boc-piperidine compound of part A (43.1 g, 0.16 mol) was added. The resulting mixture was stirred at ambient temperature for 22 hours and then filtered through a pad of Celite®, washing with acetone. The

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residue was washed with diethyl ether and the solids were collected by filtration to provide the sulfide as a yellow oil (47.6 g, 93%).

Part C: To a solution of the sulfide of  
5 part B (47.3 g, 0.15 mol) in dichloromethane (350 mL), cooled to zero degrees Celsius, was added m-chloroperoxy-benzoic acid (80 g, 57-86%). Additional dichloromethane (50 mL) was added and the mixture was stirred at zero degrees Celsius for 1 hour and then  
10 for 1.5 hours at ambient temperature. The reaction mixture was diluted with H<sub>2</sub>O and aqueous sodium metabisulfite (4.0 g in 50 mL) was added. The mixture was concentrated in vacuo and then extracted with diethyl ether and ethyl acetate. The combined  
15 organic layers were washed with 10% NH<sub>4</sub>OH, saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Recrystallization from ethyl acetate provided the sulfone as a white solid (18.9 g, 36%).

Part D: To a solution of the sulfone of  
20 part C (8.00 g, 23.3 mmol) in *N,N*-dimethylformamide (40 mL) were added 4-chlorophenol (3.59 g, 27.96 mmol) and K<sub>2</sub>CO<sub>3</sub> (22.77 g, 69.90 mmol). The resulting mixture was heated at 60 degrees Celsius for 4 hours and then increased to 80 degrees Celsius for 7 hours.  
25 The reaction was cooled to ambient temperature and then concentrated in vacuo. To the residue was added H<sub>2</sub>O (100 mL) and the solids were collected by filtration to give the biaryl ether as an off-white solid (10.5 g, 99%).

30 Part E: To a solution of the biaryl ether of part D (5.00 g, 11.1 mmol) in tetrahydrofuran (50

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mL), cooled to zero degrees Celsius, was added lithium bis(trimethylsilyl)amide (13.3 mL, 1M in tetrahydrofuran, 13.3 mmol), at such a rate that the temperature of the reaction mixture never exceeded 2  
5 degrees Celsius. The resulting mixture was stirred at zero degrees Celsius for 30 minutes, then dimethyl carbonate (1.40 mL, 16.6 mmol) was slowly added at such a rate that the temperature of the reaction mixture never exceeded 2 degrees Celsius. The  
10 resulting mixture was then slowly permitted to warm to ambient temperature.

After 17 hours, the reaction was recooled to zero degrees Celsius and additional lithium bis(trimethylsilyl)amide (5.50 mL, 1M in  
15 tetrahydrofuran, 5.50 mmol) was slowly added at a rate such that the temperature of the reaction never exceeded 2 degrees Celsius. After stirring for 30 minutes, dimethyl carbonate (0.048 mL, 0.570 mmol) was added and stirring was continued at zero degrees  
20 Celsius for 45 minutes. Additional lithium bis(trimethylsilyl)amide (0.500 mL, 1M in tetrahydrofuran, 0.500 mmol) was slowly added and after 1 hour additional dimethyl carbonate (0.010 mL, 0.119 mmol) was added. After stirring at zero  
25 degrees Celsius for 20 minutes, saturated  $\text{NH}_4\text{Cl}$  was added and the reaction mixture was then concentrated *in vacuo*. The residue was diluted with  $\text{H}_2\text{O}$  and extracted with ethyl acetate. The combined organic layers were washed with saturated NaCl and dried over  
30  $\text{Na}_2\text{SO}_4$ . Recrystallization from methanol provided the



methyl ester as a white crystalline solid (3.56 g, 63%).

Part F: To a solution of the methyl ester of part E (3.54 g, 6.94 mmol) in dioxane (18 mL) and methanol (6 mL) was added a solution of 4N HCl in dioxane (10 mL). The resulting mixture was stirred at ambient temperature for 5 hours and then concentrated *in vacuo* to provide the amine as an off-white solid (3.10 g, quantitative yield).

Part G: To a solution of the amine of part F (1.50 g, 3.36 mmol) in acetonitrile (15 mL) were added tert-butylbromoacetate (0.570 mL, 3.53 mmol) and K<sub>2</sub>CO<sub>3</sub> (1.16 g, 8.40 mmol). The resulting mixture was stirred at ambient temperature for 3 hours, then filtered through a pad of Celite®, washing with ethyl acetate. The filtrate was concentrated *in vacuo* to provide the tert-butyl ester as a pale yellow oil (1.83 g, >100%).

Part H: To a solution of the tert-butyl ester of part G (1.76 g, 3.36 mmol) in tetrahydrofuran (15 mL) was added potassium trimethylsilanolate (0.475 g, 3.70 mmol). The resulting mixture was stirred at ambient temperature overnight (about 18 hours) and additional tetrahydrofuran (10 mL) was added. After stirring at ambient temperature overnight (about 18 hours), additional potassium trimethylsilanolate (0.475 g, 3.70 mmol) was added. The resulting mixture was stirred at ambient temperature for 4 hours then diluted with H<sub>2</sub>O. The reaction mixture was acidified (pH=7) with 1N HCl and then concentrated *in vacuo*.

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The solids were washed with diethyl ether and then with H<sub>2</sub>O to provide the acid as an off-white solid (0.597 g, 32%).

Part I: To a suspension of the acid of  
5 part H (0.597 g, 1.17 mmol) in dichloromethane (5 mL) was added *N*-methylmorpholine (0.386 mL, 3.51 mmol) and *O*-tetrahydro-2H-pyran-2-yl-hydroxylamine (0.151 g, 1.29 mmol), followed by PyBroP® (0.655 g, 1.40 mmol). The resulting mixture was stirred at ambient  
10 temperature overnight (about 18 hours) and then concentrated *in vacuo*. The residue was partitioned between H<sub>2</sub>O and ethyl acetate. The organic layer was washed with saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Chromatography (on silica, ethyl acetate/hexane)  
15 provided the protected hydroxamate as a white foam (0.510 g, 72%).

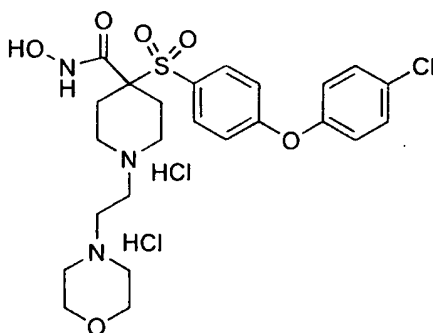
Part J: The protected hydroxamate of part I (0.510 g, 0.837 mmol) was treated with a solution of 4N HCl in dioxane (10 mL). The resulting mixture  
20 was stirred at ambient temperature for 24 hours, then diethyl ether (20 mL) was added and the solids were collected by filtration to provide the title compound as a white solid (0.370 g, 87%). MS MH<sup>+</sup> calculated for C<sub>20</sub>H<sub>22</sub>O<sub>7</sub>N<sub>2</sub>SCl: 469, found 469.

25

Example 89: Preparation of 4-[[4-(4-chlorophenoxy)-phenyl]sulfonyl]-*N*-hydroxy-1-[2-(4-morpholinyl)ethyl]-4-piperidine-  
carboxamide, dihydrochloride

30

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Part A: To a solution of the amine of part F, Example 88 (1.00 g, 2.24 mmol) in acetonitrile (10 mL) were added 4-(2-chloroethyl)morpholine (0.438 g, 2.35 mmol) and  $K_2CO_3$  (1.24 g, 8.96 mmol). The resulting mixture was stirred at ambient temperature for 1.5 hours then a catalytic amount of NaI was added and stirring was continued at ambient temperature for 21 hours. The temperature of the reaction mixture was then increased to 60 degrees Celsius for 29 hours. After cooling to ambient temperature, the reaction mixture was filtered through a pad of Celite®, washing with ethyl acetate. The filtrate was concentrated in vacuo to provide the ester as an oily solid (1.15 g, 98%).

Part B: To a solution of the ester of part A (1.15 g, 2.20 mmol) in tetrahydrofuran (10 mL) was added potassium trimethylsilanolate (0.579 g, 4.51 mmol). The reaction mixture was stirred at ambient temperature for 4 hours then additional tetrahydrofuran (10 mL) was added and stirring was continued at ambient temperature overnight (about 18 hours). The reaction mixture was diluted with  $H_2O$  (10 mL) and acidified (pH-7) with 1N HCl. The resulting

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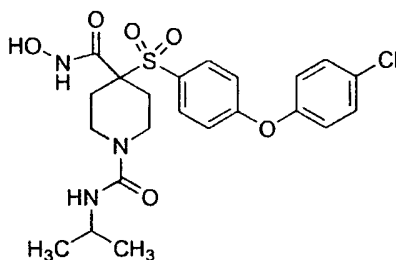
precipitate was collected by filtration to provide the acid as a gray solid (0.753 g, 72%).

Part C: To a suspension of the acid of part B (0.750 g, 1.47 mmol) in dichloromethane (7 mL) were added *N*-methylmorpholine (0.500 mL, 4.55 mmol), and *O*-tetrahydro-2H-pyran-2-yl-hydroxylamine (0.198 g, 1.62 mmol), followed by PyBroP® (0.822 g, 1.76 mmol). The resulting mixture was stirred at ambient temperature for 24 hours then additional *N*-methylmorpholine (0.242 mL, 2.21 mmol), *O*-tetrahydro-2H-pyran-2-yl-hydroxylamine (0.052 g, 0.441 mmol) and PyBroP® (0.343 g, 0.735 mmol) were added. The resulting mixture was stirred at ambient temperature for 23 hours and then additional *O*-tetrahydro-2H-pyran-2-yl-hydroxylamine (0.017 g, 0.145 mmol) and PyBroP® (0.073 g, 0.157 mmol) were added. The resulting mixture was stirred at ambient temperature overnight (about 18 hours) and then concentrated *in vacuo*. The residue was partitioned between H<sub>2</sub>O and ethyl acetate. The organic layer was washed with saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Chromatography (on silica, methanol/chloroform) provided the protected hydroxamate as an off-white solid (0.750 g, 84%).

Part D: The protected hydroxamate of part C (0.730 g, 1.20 mmol) was treated with a solution of 4N HCl in dioxane (10 mL) and methanol (1 mL). The resulting mixture was stirred at ambient temperature for 1 hour, then diethyl ether (20 mL) was added and the solids were collected by filtration to provide the title compound as a pale yellow solid (0.625 g,

87%). MS  $MH^+$  calculated for  $C_{24}H_{31}O_6N_3SCl$ : 525, found 525.

Example 90: Preparation of 4-[[4-(4-chlorophenoxy)-  
5 phenyl]sulfonyl]-N<sup>4</sup>-hydroxy-N<sup>1</sup>-(1-methylethyl)-1,4-piperidine  
dicarboxamide



10

Part A: To a suspension of the amine of part F, Example 88 (0.600 g, 1.34 mmol) in dichloromethane (5 mL) were added triethylamine (0.411 mL, 2.95 mmol) and isopropyl isocyanate (0.198  
15 mL, 2.01 mmol). The resulting mixture was stirred at ambient temperature for 2 hours then diluted with dichloromethane (50 mL). The mixture was washed with  $H_2O$ , saturated NaCl and dried over  $Na_2SO_4$  to give the urea as an off-white solid (0.670 g, >100%).

20 Part B: To a solution of the urea of part A (0.640 g, 1.29 mmol) in tetrahydrofuran (10 mL) was added potassium trimethylsilanolate (0.199 g, 1.55 mmol). The resulting mixture was stirred at ambient temperature for 17 hours at which time additional  
25 potassium trimethylsilanolate (0.015 g, 0.117 mmol) was added. The resulting mixture was stirred for an additional 24 hours then the tetrahydrofuran was

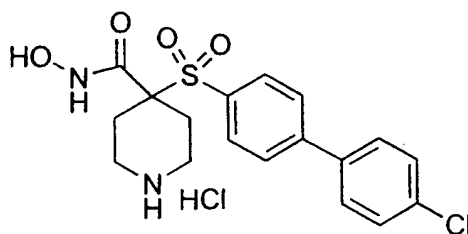
-460-

removed by blowing N<sub>2</sub> over the mixture. To a suspension of the residue in dichloromethane (5 mL) were added *N*-methylmorpholine (0.426 mL, 3.87 mmol) and *O*-tetrahydro-2H-pyran-2-yl-hydroxylamine (0.181 g, 1.55 mmol), followed by PyBroP<sup>®</sup> (0.902 g, 1.94 mmol). The resulting mixture was stirred at ambient temperature for 7 hours and then concentrated in vacuo. The residue was partitioned between H<sub>2</sub>O and ethyl acetate. The organic layer was washed with saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Chromatography (on silica, ethyl acetate/hexane) provided the protected hydroxamate as an off-white solid (0.330 g, 44%).

Part C: To a solution of the protected hydroxamate of part B (0.330 g, 0.569 mmol) in dioxane (3 mL) and methanol (1 mL) was added a solution of 4N HCl in dioxane (10 mL). The resulting mixture was stirred at ambient temperature for 3.5 hours then diethyl ether was added. The solids were collected by filtration to give the title compound as a white solid (0.259 g, 92%). MS MH<sup>+</sup> calculated for C<sub>22</sub>H<sub>27</sub>O<sub>6</sub>N<sub>3</sub>SCl: 496, found 496.

Example 91: Preparation of 4-[(4'-chloro[1,1'-biphenyl]-4-yl)sulfonyl]-*N*-hydroxy-4-piperidinecarboxamide, monohydrochloride

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Part A: To a solution of 4-bromothiophenol (16.98 g, 89.80 mmol) in acetone (200 mL), degassed with N<sub>2</sub>, was added K<sub>2</sub>CO<sub>3</sub> (12.41 g, 89.80 mmol). After degassing the resulting mixture with N<sub>2</sub> for 5 minutes, the Boc-piperidine compound of part A, Example 88 (21.57 g, 81.64 mmol) was added. The resulting mixture was stirred at ambient temperature for 19 hours and then filtered through a pad of Celite®, washing with acetone. The residue was washed with diethyl ether and the solids were collected by filtration to provide the sulfide as a green oil (31.7 g, >100%).

Part B: To a solution of the sulfide of part A (31.68 g, 81.64 mmol) in dichloromethane (200 mL), cooled to zero degrees Celsius, was added m-chloroperoxybenzoic acid (56.35 g, 50-60%, 163.28 mmol). The resulting mixture became very thick, and additional dichloromethane (100 mL) was added. The mixture was stirred at zero degrees Celsius for 1.5 hours and then at ambient temperature for 1.5 hours. The reaction mixture was diluted with H<sub>2</sub>O (300 mL) and aqueous sodium meta-bisulfite (8.00 g, 42.08 mmol in 50 mL of H<sub>2</sub>O) was added. The dichloromethane was removed in vacuo and the aqueous reaction mixture was extracted with ethyl acetate. The combined organic

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layers were washed with 10%  $\text{NH}_4\text{OH}$ , saturated  $\text{NaCl}$  and dried over  $\text{Na}_2\text{SO}_4$ . Concentration *in vacuo* provided the sulfone as a yellow oil (33.42 g, >100%).

Part C: To a solution of the sulfone of  
5 part B (7.80 g, 19.34 mmol) in tetrahydrofuran (100 mL), cooled to zero degrees Celsius, was added lithium bis(trimethylsilyl)amide (23.8 mL, 1M in tetrahydrofuran, 23.8 mmol) at such a rate that the temperature of the reaction never exceeded 2 degrees  
10 Celsius. After stirring at zero degrees Celsius for 30 minutes a solution of methyl chloroformate (2.30 mL, 29.8 mmol) in tetrahydrofuran (5 mL) was added at such a rate that the temperature of the reaction never exceeded 2 degrees Celsius. The resulting  
15 mixture was then slowly allowed to warm to ambient temperature. The mixture was diluted with saturated  $\text{NH}_4\text{Cl}$  and the tetrahydrofuran was removed *in vacuo*. The aqueous layer was extracted with ethyl acetate. The combined organic layers were washed with  
20 saturated  $\text{NaCl}$  and dried over  $\text{Na}_2\text{SO}_4$ . Chromatography (on silica, ethyl acetate/hexane) provided the ester as a yellow solid (6.33 g, 69%).

Part D: To a solution of the ester of part C (4.74 g, 10.28 mmol) in dimethoxyethane (50 mL)  
25 were added 4-chlorophenylboronic acid (1.77 g, 11.30 mmol), aqueous  $\text{Cs}_2\text{CO}_3$  (25 mL, 2.0 M, 50.0 mmol) and tetrakis(triphenylphosphine)palladium (0) (1 g). The resulting mixture was stirred at ambient temperature for 3 days. The reaction mixture was filtered  
30 through a pad of Celite®, washing with ethyl acetate, and the filtrate was concentrated *in vacuo*.



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Chromatography (on silica, ethyl acetate/hexane) provided the biphenyl compound as an off-white solid (4.16 g, 82%).

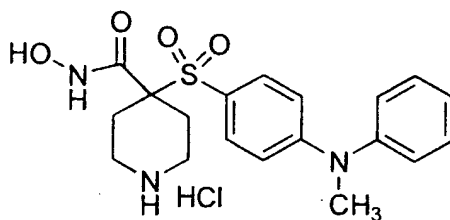
Part E: To a solution of the biphenyl  
5 compound of part D (1.50 g, 3.04 mmol) in tetrahydrofuran (10 mL) was added potassium trimethylsilanolate (0.468 g, 3.65 mmol). The resulting mixture was stirred at ambient temperature for 1 hour, additional tetrahydrofuran (5 mL) was  
10 added and the reaction mixture was stirred at ambient temperature overnight (about 18 hours). Additional tetrahydrofuran (15 mL) was added and the mixture was stirred for another 26 hours at ambient temperature. Additional potassium trimethylsilanolate (0.040 g,  
15 0.304 mmol) was added and the mixture was stirred at ambient temperature overnight (about 18 hours) and then the solvent was removed by blowing N<sub>2</sub> over the reaction mixture.

To a suspension of the residue in  
20 dichloromethane (20 mL) were added added N-methylmorpholine (1.00 mL, 9.12 mmol), O-tetrahydro-2H-pyran-2-yl-hydroxylamine (0.427 g, 3.65 mmol), followed by PyBroP® (2.13 g, 4.56 mmol). The resulting mixture was stirred at ambient temperature  
25 for 24 hours and then concentrated *in vacuo*. The residue was partitioned between H<sub>2</sub>O and ethyl acetate. The organic layer was washed with saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Chromatography (on silica, ethyl acetate/hexane) provided the protected hydroxamate as  
30 a white solid (1.25 g, 71%).

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Part F: To a solution of the protected hydroxamate of part E (1.25 g, 2.16 mmol) in dioxane (3 mL) and methanol (1 mL) was added a solution of 4N HCl in dioxane (10 mL). The resulting mixture was stirred at ambient temperature for 3.5 hours, then diethyl ether (20 mL) was added. The solids were collected by filtration to give the title compound as a white solid (0.900 g, 97%). MS MH<sup>+</sup> calculated for C<sub>18</sub>H<sub>20</sub>O<sub>4</sub>N<sub>2</sub>SCl: 395, found 395.

Example 92: Preparation of N-hydroxy-4-[[4-(methylphenylamino)phenyl]sulfonyl]-4-piperidinecarboxamide, monohydrochloride



Part A: To a solution of the ester of part C, Example 91 (1.00 g, 2.17 mmol) in toluene (4 mL) were added N-methylaniline (0.282 mL, 2.60 mmol), Cs<sub>2</sub>CO<sub>3</sub> (0.990 g, 3.04 mmol), tris(dibenzylideneacetone)-dipalladium(0) (0.018 g, 0.02 mmol) and (R)-(+)-2,2'-bis(diphenylphosphino)1,1'-binaphthyl (BINAP; 0.021 g, 0.033 mmol). The resulting mixture was heated to 100 degrees Celsius for 20 hours. After cooling to ambient temperature, diethyl ether was added, the mixture was filtered through a pad of Celite®,

washing with diethyl ether, and the filtrate was concentrated *in vacuo*. Chromatography (on silica, ethyl acetate/hexane) provided the aniline as a yellow sticky gum (0.930 g, 88%).

5                   Part B: To a solution of the aniline of part A (0.930 g, 1.90 mmol) in tetrahydrofuran (10 mL) was added potassium trimethylsilanolate (0.293 g, 2.28 mmol). The resulting mixture was stirred at ambient temperature for 19 hours and then additional  
10 potassium trimethylsilanolate (0.024 g, 0.190 mmol) was added. After stirring at ambient temperature overnight (about 18 hours) the solvent was removed by blowing N<sub>2</sub> over the mixture.

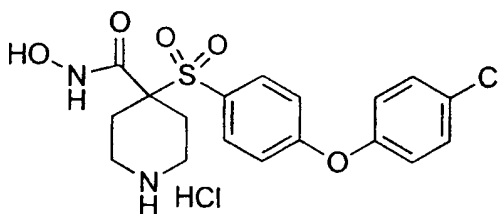
To a suspension of the residue in  
15 dichloromethane (10 mL) were added added *N*-methylmorpholine (0.627 mL, 5.70 mmol), *O*-tetrahydro-2H-pyran-2-yl-hydroxylamine (0.267 g, 2.28 mmol), followed by PyBroP® (1.33 g, 2.85 mmol). The resulting mixture was stirred at ambient temperature  
20 for 2 days and then concentrated *in vacuo*. The residue was partitioned between H<sub>2</sub>O and ethyl acetate. The organic layer was washed with saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Chromatography (on silica, ethyl acetate/hexane) provided the protected hydroxamate as  
25 a white solid (0.860 g, 79%).

Part C: To a solution of the protected hydroxamate of part B (0.890 g, 1.55 mmol) in dioxane (3 mL) and methanol (1 mL) was added a solution of 4*N* HCl in dioxane (5 mL). The resulting mixture was  
30 stirred at ambient temperature for 1 hour, then diethyl ether (15 mL) was added. The solids were

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collected by filtration to give the title compound as a white solid (0.529 g, 80%). MS  $MH^+$  calculated for  $C_{19}H_{24}O_4N_3S$ : 390, found 390.

- 5 Example 93: Preparation of 4-[[4-(4-chlorophenoxy)-phenyl]sulfonyl]-N-hydroxy-4-  
piperidinecarboxamide, monohydrochloride



10

- Part A: To a suspension of resin I (4.98 g, 5.87mmol) in 1-methyl-2-pyrrolidinone (45 mL), in a peptide flask, were added the acid of part A,
- 15 Example 83 (4.55 g, 11.74 mmol), benzotriazole-1-yl-oxy-tris-pyrrolidino-phosphonim hexafluorophosphate (6.11 g, 11.74 mmol) and *N*-methymorpholine (2.58 mL, 23.48 mmol). The resulting mixture was agitated at ambient temperature for 14 hours. The resin was then
- 20 collected by filtration, the filtrate was removed and set aside, and the resin was washed with *N,N*-dimethylformamide,  $H_2O$ , *N,N*-dimethylformamide, methanol, dichloromethane and finally with diethyl ether. The resin was dried *in vacuo* at ambient
- 25 temperature to give the resin bound *p*-fluorosulfone as a yellow solid (6.72 g, 95%).

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The filtrate was diluted with H<sub>2</sub>O and extracted with ethyl acetate. The aqueous layer was acidified (pH-2.0) with 2N HCl and then extracted with ethyl acetate. The organic layer was washed  
5 with saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. The resulting residue was dissolved in 1-methyl-2-pyrrolidinone (40 mL), the above resin was added, followed by *N*-methyilmorpholine (1.50 mL, 13.64 mmol) and benzotriazole-1-yl-oxy-tris-pyrrolidino-  
10 phosphonim hexafluorophosphate (3.05 g, 5.86 mmol). The resulting mixture was agitated at ambient temperature for 3.5 hours. The resin was then collected by filtration and washed with *N,N*-dimethylformamide, H<sub>2</sub>O, *N,N*-dimethylformamide,  
15 methanol, dichloromethane and finally with diethyl ether. The resin was dried in vacuo at ambient temperature to give the resin bound *p*-fluorosulfone as a pale orange solid (6.34 g, 89%). The loading (0.78 mmol/g) was determined by cleaving a small  
20 portion of the resin bound *p*-fluorosulfone with 95% trifluoroacetic acid/H<sub>2</sub>O.

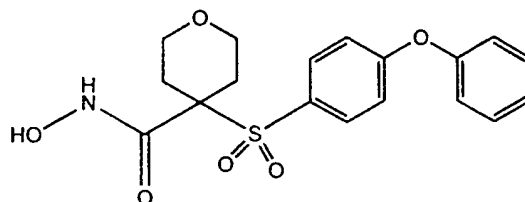
Part B: To a suspension of the resin bound *p*-fluorosulfone (0.700 g, 0.546 mmol) in 1-methyl-2-pyrrolidinone (3 mL) was added *p*-chlorophenol (0.702  
25 g, 5.46 mmol) and Cs<sub>2</sub>CO<sub>3</sub> (1.78 g, 5.46 mmol). The resulting mixture was heated to 110 degrees Celsius for 13 hours. The resin was then collected by filtration and washed consecutively with *N,N*-dimethylformamide, H<sub>2</sub>O, *N,N*-dimethylformamide, 2N HCl,  
30 *N,N*-dimethylformamide, methanol, and dichloromethane. The resulting resin was resubjected to the above

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reaction conditions for 3 hours. The resin was then collected by filtration and washed consecutively with *N,N*-dimethylformamide, H<sub>2</sub>O, *N,N*-dimethylformamide, 2*N* HCl, *N,N*-dimethylformamide, methanol, and  
5 dichloromethane. The solid was dried *in vacuo* at ambient temperature to provide the resin bound hydroxamate as an orange solid (0.692 g, 91%).

Part C: The resin bound hydroxamate of part B (0.692 g, 0.540 mmol) was treated with 95%  
10 trifluoroacetic acid/H<sub>2</sub>O (3 mL) for 1 hour at ambient temperature. The resin was filtered and washed with 95% trifluoroacetic acid/H<sub>2</sub>O (3 mL) and then dichloromethane (2x 3 mL). The filtrate was then evaporated. Reverse phase chromatography (on silica,  
15 acetonitrile/H<sub>2</sub>O/ trifluoroacetic acid) provided the hydroxamate. The resulting solid was dissolved in acetonitrile (5 mL) and H<sub>2</sub>O (0.5 mL) and treated with concentrated HCl. The resulting mixture was stirred at ambient temperature for 5 minutes and the  
20 concentrated *in vacuo* to provide the title compound as an off-white solid (0.220 g, 91%). MS MH<sup>+</sup> calculated for C<sub>18</sub>H<sub>20</sub>O<sub>5</sub>N<sub>2</sub>SO<sub>2</sub>: 411, found 411.

Example 94: Preparation of Tetrahydro-*N*-hydroxy-4-  
25 [(4-phenoxyphenyl)sulfonyl]-2*H*-pyran-  
4-carboxamide



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Part A: To a stirred solution of the methyl ester compound of Example 55, part C, (0.96 g, 3.2 mmol) in N,N-dimethylformamide (30 mL) was added  
5 phenol (0.3 g, 3.2 mmol), followed by cesium carbonate (3.2 g, 10 mmol). The resulting composition was heated to 70 degrees Celsius for 5 hours. The solution remained at ambient temperature for 18 hours, was diluted with H<sub>2</sub>O and extracted with  
10 ethyl acetate. The organic layer was washed with half-saturated NaCl and dried over sodium sulfate. The solvent was removed by rotary evaporation to yield the desired phenoxy compound (1.1 g, 92%).

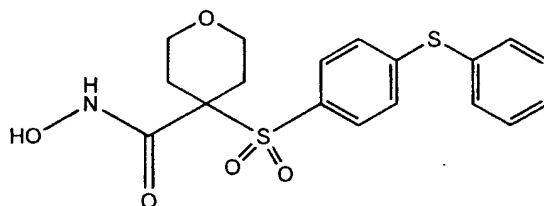
Part B: Sodium hydroxide (1 g, 25 mmol)  
15 was added to a solution of the phenoxy compound of part A (1.1 g, 2.9 mmol) in THF (10 mL) and ethanol (10 mL). The resulting solution was stirred at ambient temperature for 1 hour. The solution was then heated to 80 degrees Celsius for 1 hour. The  
20 solvent was removed by rotary evaporation and the resulting sodium salt was acidified with 1 N HCl (50 mL) and extracted with ethyl acetate. The organic layer was dried over Na<sub>2</sub>SO<sub>4</sub>. The solvent was removed by rotary evaporation to yield the desired phenoxy  
25 carboxylic acid (1.1 g, 99%).

Part C: To a stirred solution of the phenoxy carboxylic acid of part B (1.1 g, 3 mmol) in DMF (7 mL) was added N-hydroxybenzotriazole-H<sub>2</sub>O (0.623 g, 4.6 mmol), followed by 1-[3-  
30 (dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (0.634 g, 3.3 mmol). After 10 minutes,

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a 50% aqueous hydroxylamine solution was added (2 mL, 30 mmol) and the solution was stirred at ambient temperature for 18 hours. The solution was diluted with saturated sodium bicarbonate and extracted with ethyl acetate. The organic layer was washed with H<sub>2</sub>O and followed by half-saturated NaCl and then dried over Na<sub>2</sub>SO<sub>4</sub>. Reverse phase chromatography (on silica, acetonitrile/H<sub>2</sub>O) provided the title compound as a white solid (0.37 g, 33%). HRMS (ES<sup>+</sup>) MH<sup>+</sup> for C<sub>18</sub>H<sub>19</sub>NO<sub>6</sub>S 378.1011. Found: 378.0994.

Example 95: Preparation of Tetrahydro-N-hydroxy-4-  
[[4-(phenylthio)phenyl]sulfonyl]-2H-  
pyran-4-carboxamide



Part A: To a stirred solution under a nitrogen atmosphere of the methyl ester of Example 55, part C, (1.02 g, 3.4 mmol) in N,N-dimethylformamide (20 mL) was added thiophenol (0.37 g, 3.4 mmol), followed by cesium carbonate (3.3g, 10.1 mmol) and the solution was heated to 70 degrees Celsius for 17 hours. The solution remained at ambient temperature for 1 hour, was diluted with H<sub>2</sub>O and extracted with ethyl acetate. The organic layer was washed with half-saturated NaCl and dried over



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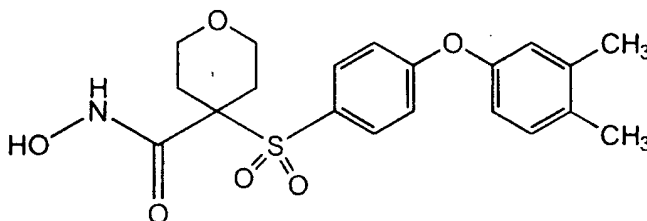
Na<sub>2</sub>SO<sub>4</sub>. Chromatography (on silica, ethyl acetate/hexane) provided the S-phenyl compound (0.6 g, 41%).

Part B: To a stirred solution of the S-phenyl compound of part A (0.6 g, 1.4 mmol) in THF (10 mL) and ethanol (10 mL) was added NaOH (0.8 g, 20 mmol). The solution was heated to 80 degrees Celsius for 1 hour. The solution remained at ambient temperature for 18 hours. The solvent was removed by rotary evaporation, the resulting sodium salt was acidified with 1 N HCl (25 mL), extracted with ethyl acetate, and the organic layer was dried over sodium sulfate. The solvent was removed by rotary evaporation to yield the desired S-phenyl carboxylic acid (0.6 g, quantitative yield).

Part C: To a stirred solution of the S-phenyl carboxylic acid of part B (0.6 g, 1.5 mmol) in DMF (6 mL) was added N-hydroxybenzotriazole-H<sub>2</sub>O (0.30 g, 2.2 mmol), followed by 1-[3-(dimethylamino)-propyl]-3-ethylcarbodiimide hydrochloride (0.32 g, 1.6 mmol). After 10 minutes, a 50% aqueous hydroxylamine solution was added (1.5 mL, 22 mmol) and the solution was stirred at ambient temperature 42 hours. The solution was diluted with saturated sodium bicarbonate and extracted with ethyl acetate. The organic layer was washed with H<sub>2</sub>O, followed by half-saturated NaCl and dried over sodium sulfate. Reverse phase chromatography (on silica, acetonitrile/H<sub>2</sub>O) provided the title compound as a white solid (0.15 g, 26%). HRMS (ES<sup>+</sup>) MH<sup>+</sup> for C<sub>18</sub>H<sub>19</sub>NO<sub>5</sub>S<sub>2</sub> 394.0783. Found: 394.0753.

Example 96: Preparation of 4-[[4-(3,4-dimethylphenoxy)phenyl]sulfonyl]tetrahydro-N-hydroxy-2H-pyran-4-carboxamide

5



Part A: To a stirred solution of the methyl ester Example 55, part C, (1.04 g, 3.3 mmol) in N,N-dimethylformamide (30 mL) was added 3,4-dimethylphenol (0.4g, 3.3 mmol), followed by cesium carbonate (3.2 g, 10 mmol). The resulting solution was heated to 88 degrees Celsius for 5 hours. The solution was concentrated by rotary evaporation, diluted with H<sub>2</sub>O and extracted with ethyl acetate. The organic layer dried over MgSO<sub>4</sub>. The solvent was removed by rotary evaporation to yield the desired dimethylphenoxy compound (1.2g, 91%).

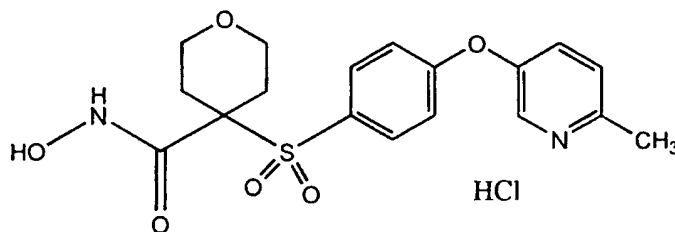
Part B: To a solution of the dimethylphenoxy compound of part A (1.2 g, 3 mmol) in THF (10 mL) and ethanol (10 mL) was added NaOH (1 g, 25 mmol). The resulting solution was heated to 80 degrees Celsius for 1 hour. The solvent was removed by rotary evaporation, the resulting sodium salt was acidified with 1 N HCl (50 mL) and extracted with ethyl acetate. The organic layer was dried over sodium sulfate. The solvent was removed by rotary

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evaporation to yield the desired dimethylphenoxy carboxylic acid (1.2 g, quantitative yield).

Part C: To a stirred solution of the dimethylphenoxy carboxylic acid of part B (1.2 g, 3 mmol) in DMF (7 mL) was added N-hydroxybenzotriazole-H<sub>2</sub>O (0.623 g, 4.6 mmol), followed by 1-[3-(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (0.634 g, 3.3 mmol). After 10 minutes, a 50% aqueous hydroxylamine solution was added (2 mL, 30 mmol) and the solution was stirred at ambient temperature 18 hours. The solution was diluted with saturated sodium bicarbonate and extracted with ethyl acetate. The organic layer was washed with H<sub>2</sub>O and followed half-saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Reverse phase chromatography (on silica, acetonitrile/H<sub>2</sub>O) provided the title compound as a white solid (0.52 g, 43%). HRMS (ES<sup>+</sup>) MH<sup>+</sup> for C<sub>20</sub>H<sub>23</sub>NO<sub>6</sub>S 406.1324. Found: 406.1302.

Example 97: Preparation of Tetrahydro-N-hydroxy-4-[[4-[(6-methyl-3-pyridinyl)oxy]phenyl]-sulfonyl]-2H-pyran-4-carboxamide, monohydrochloride



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Part A: To a stirred solution of the methyl ester of Example 55, Part C, (1.02 g, 3.4 mmol) in N,N-dimethylformamide (20 mL) was added 5-hydroxy-2-methyl-pyridine (0.54g, 5 mmol), followed by cesium carbonate (3.2g, 10 mmol). The resulting solution was heated to 70 degrees Celsius for 5 hours. The solution remained at ambient temperature for 4 days, then was diluted with H<sub>2</sub>O and extracted with ethyl acetate. The organic layer was washed with half-saturated NaCl and dried over sodium sulfate. The solvent was removed by rotary evaporation to yield a heavy oil from which the desired white methyl pyridine compound crystallized at ambient temperature in vacuo (1.2 g, 94%).

Part B: To a solution of the methyl pyridine compound of part A (1.2 g, 3.2 mmol) in THF (13 mL) was added potassium trimethylsilanoate (0.5 g, 3.5 mmol). The resulting solution was stirred at ambient temperature for 18 hours, during which time a gel formed. The solvent was removed by rotary evaporation to yield the desired methyl pyridine carboxylic acid (1.4g, quantitative yield).

Part C: To a stirred solution of the methyl pyridine carboxylic acid of part B (1.4 g, 3.2 mmol) in methylene chloride (10 mL) was added bromotris-pyrrolidino-phosphonium hexafluorophosphate (1.79 g, 3.8 mmol), followed by 4-methylmorpholine (0.97 g, 9.6 mmol), followed by O-tetrahydro-2H-pyran-yl-hydroxylamine (0.41 g, 3.5 mmol) and the solution was stirred at ambient temperature for 1.5 hours. The solution was filtered to remove a

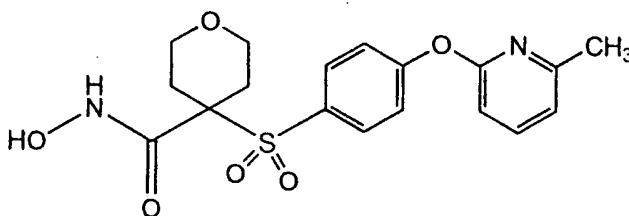
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precipitate and the solvent was removed by rotary evaporation. Chromatography (on silica, ethyl acetate/hexane) provided the O-tetrahydropyran methyl pyridine as a white solid (1.48 g, 97%).

- 5           Part D: Methanol (3 mL) was added to a stirred solution of the O-tetrahydropyran methyl pyridine of part C (1.48 g, 3.1 mmol) in 4 N HCl in dioxane (5 mL). The solution was stirred at ambient temperature for 3 hours and poured into ethyl ether.
- 10 The resulting precipitate was collected by vacuum filtration. Reverse phase chromatography (on silica, acetonitrile/H<sub>2</sub>O/HCl) provided the title compound as a white solid (0.64 g, 53%). HRMS (ES<sup>+</sup>) MH<sup>+</sup> for C<sub>18</sub>H<sub>20</sub>N<sub>2</sub>O<sub>6</sub>S 393.1120. Found: 393.1110.

15

Example 98: Preparation of Tetrahydro-N-hydroxy-4-  
[[4-[(6-methyl-2-pyridinyl)oxy]phenyl]-  
sulfonyl]-2H-pyran-4-carboxamide



20

- Part A: To a stirred solution of the methyl ester of Example 55, part C, (1.0 g, 3.3 mmol) in N,N-dimethylformamide (20 mL) was added 2-hydroxy-  
25 6-methyl-pyridine (0.54 g, 5 mmol), followed by cesium carbonate (3.2g, 10 mmol). The resulting solution was heated to 70 degrees Celsius for 5

hours. The solution remained at ambient temperature for 11 hours, at which time additional 2-hydroxy-6-methyl-pyridine (0.3 g, 2.7 mmol) was added to the stirred solution and the resulting solution was  
5 heated to 70 degrees Celsius for 3 hours. The solution was concentrated by rotary evaporation, diluted with saturated NaCl in H<sub>2</sub>O and extracted with ethyl acetate. The organic layer was dried over sodium sulfate. The solvent was removed by rotary  
10 evaporation and chromatography (on silica, ethyl acetate/methanol) provided the desired methyl pyridine as a white solid (0.63 g, 49%).

Part B: To a solution of the methyl pyridine compound of part A (0.63 g, 1.6 mmol) in THF  
15 (13 mL) was added potassium trimethylsilanoate (0.5 g, 3.5 mmol). The resulting solution was stirred at ambient temperature for 18 hours. The precipitate that formed was removed by filtration, washed with methylene chloride and dried *in vacuo* to provide the  
20 methyl pyridine carboxylic acid potassium salt (0.4 g, 55%).

Part C: To a stirred solution of the methyl pyridine carboxylic acid potassium salt of part B (0.4 g, 0.9 mmol) in N,N-dimethylformamide (5  
25 mL) was added bromo-tris-pyrrolidino-phosphonium hexafluorophosphate (0.5 g, 1 mmol), followed by 4-methylmorpholine (0.27 g, 2.6 mmol), followed by a 50% aqueous hydroxylamine solution (0.6 mL, 9 mmol). The resulting solution was stirred at ambient  
30 temperature 32 hours. The solution was concentrated by rotary evaporation and reverse phase

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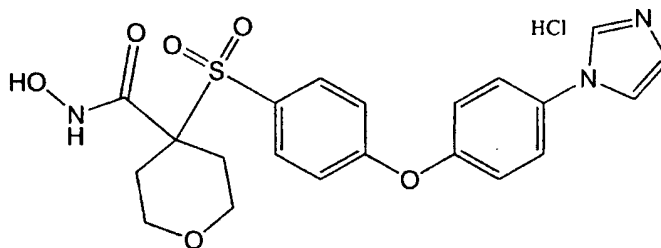
chromatography (on silica, acetonitrile/H<sub>2</sub>O) provided the title compound as a white solid (0.162 g, 47%).

HRMS (ES<sup>+</sup>) MH<sup>+</sup> for C<sub>18</sub>H<sub>20</sub>N<sub>2</sub>O<sub>6</sub>S 393.1120. Found: 393.1119.

5

Example 99: Preparation of tetrahydro-N-hydroxy-4-  
[[4-[4-(1H-imidazol-1-yl)phenoxy]phenyl]-  
sulfonyl]-2H-pyran-4-carboxamide,  
monohydrochloride

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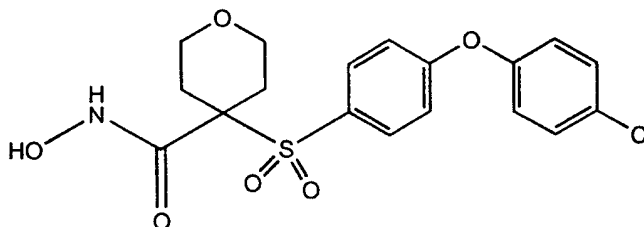
Part A: To a solution of the THP  
pyranfluoro compound of Example 55, part C, (2.0 g,  
15 5.2 mmol ) in N,N-dimethylacetamide (6 mL) was added  
4-(1,3-imidazole)phenol (12.9 g, 33.3 mmol), followed  
by cesium carbonate (32.5 g, 99.9 mmol). The  
reaction was heated at 65 degrees Celsius for twelve  
hours. Removing the dimethylacetamide *in vacuo*  
20 afforded a brown solid. Reverse phase chromatography  
(on silica, acetonitrile/water) gave the THP-  
protected product in solution.

Part B: A solution of 10% HCl<sub>aq</sub> (100 mL)  
was slowly added to the solution of the crude THP-  
25 protected product from A in acetonitrile/water (100  
mL). After stirring overnight (about 18 hours), the  
acetonitrile was removed. The resultant precipitate

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was collected, giving the title compound as a brown solid (6.0 g, 41%). MS (FAB) M<sup>+</sup>H calculated for C<sub>21</sub>H<sub>21</sub>N<sub>3</sub>O<sub>6</sub>S<sub>1</sub>: 444, found 444.

5 Example 100: Preparation of 4-[[4-(4-chlorophenoxy)-phenyl]sulfonyl]-tetrahydro-N-hydroxy-2H-pyran-4-carboxamide



10

Part A: To a stirred solution of the THP  
pyranfluoro compound of Example 55, Part C, (2.9 g,  
7.5 mmol) in N,N-dimethylformamide (15 mL) was added  
p-chloro-phenol (1.93 g, 15 mmol), followed by cesium  
15 carbonate (7.3 g, 22.5 mmol). The resulting  
composition was heated to 90 degrees Celsius for 1.5  
hours. The solution remained at ambient temperature  
for 18 hours with stirring, and dimethylformamide (20  
mL) was added to the stirred solution, followed by  
20 cesium carbonate (2 g, 6.2 mmol). The resulting  
composition was heated to 95 degrees Celsius for 3  
hours. The solution then remained at ambient  
temperature 20 hours, at which time it was diluted  
with H<sub>2</sub>O and extracted with ethyl acetate. The  
25 organic layer was washed with half-saturated NaCl and  
dried over sodium sulfate. The solvent was removed  
by rotary evaporation. Chromatography (on silica,

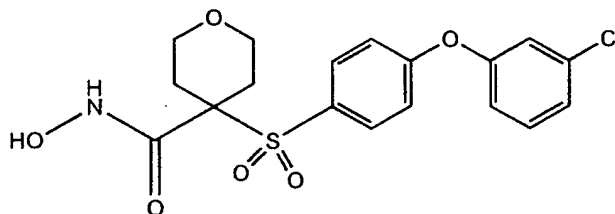


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ethyl acetate/hexane) provided the p-chloro phenoxyphenyl THP-protected hydroxamate compound (2.9 g, 78%).

Part B: To a solution of the p-chloro phenoxyphenyl THP-protected hydroxamate compound of part A (2.9 g, 5.7 mmol) in dioxane (5 mL) was added 4N HCl in dioxane (5 mL, 20 mmol), followed by methanol (7.5 mL). The resulting solution was stirred at ambient temperature for 1 hour. The solvent was removed by rotary evaporation. Reverse phase chromatography (on silica, acetonitrile/H<sub>2</sub>O) provided the title compound as a white solid (1.35 g, 58%). MS (FAB) MH<sup>+</sup> for C<sub>18</sub>H<sub>18</sub>NO<sub>6</sub>SCl 412. Found: 412.

Example 101: Preparation of 4-[[4-(3-chlorophenoxy)-phenyl]sulfonyl]tetrahydro-N-hydroxy-2H-pyran-4-carboxamide



20

Part A: To a stirred solution of the THP pyranfluoro compound of Example 55, Part C, (5.0 g, 13 mmol) in N,N-dimethylformamide (20 mL) was added p-chloro-phenol (5 g, 39 mmol), followed by cesium carbonate (17 g, 52 mmol). The resulting solution was heated to 95 degrees Celsius for 7 hours. The solution was maintained at ambient temperature for 7

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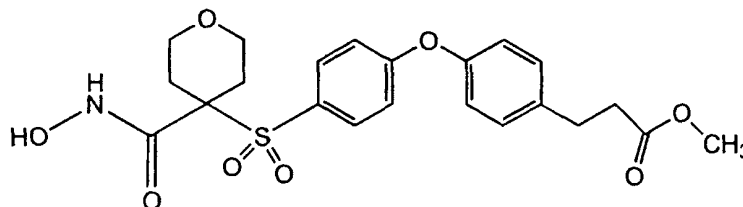
hours, diluted with H<sub>2</sub>O and extracted with ethyl acetate. The organic layer was washed with half-saturated NaCl and dried over sodium sulfate. The solution was concentrated by rotary evaporation.

5 Chromatography (on silica, ethyl acetate/hexane) provided the m-chloro phenoxyphenyl THP-protected hydroxamate compound (5.2 g, 82%).

Part B: To a solution of the m-chloro phenoxyphenyl THP-protected hydroxamate compound of  
10 part A (5.2 g, 10 mmol) in dioxane (5 mL) was added 4N HCl in dioxane (5 mL, 20 mmol), followed by methanol (10 mL). The resulting solution was stirred at ambient temperature for 1 hour. The solvent was removed by rotary evaporation to provide the title  
15 compound as a white solid (3.4 g, 79%). HRMS (ES<sup>+</sup>) M + NH<sub>4</sub><sup>+</sup> for C<sub>18</sub>H<sub>16</sub>NO<sub>6</sub>SCl 429.0887. Found: 429.0880.

Example 102: Preparation of methyl 4-[4-

20 [(tetrahydro-4-[(hydroxyamino)carbonyl]-2H-pyran-4-yl)sulfonyl]-  
phenoxy]benzenepropanoate



25 Part A: To a stirred solution of the THP pyranfluoro compound of Example 55, part C, (5.0 g, 13 mmol) in N,N-dimethylformamide (45 mL) was added

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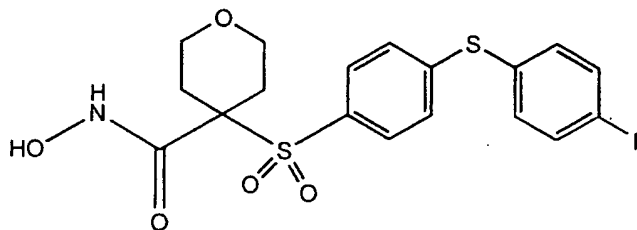
methyl 3-(4-hydroxyphenyl)-propanoate (7 g, 39 mmol), followed by cesium carbonate (17 g, 52 mmol). The resulting composition was heated to 95 degrees Celsius for 7 hours. The solution then remained at ambient temperature for 7 hours. The solution was thereafter diluted with H<sub>2</sub>O and extracted with ethyl acetate. The organic layer was washed with half-saturated NaCl and dried over sodium sulfate. The solution was concentrated by rotary evaporation. Chromatography (on silica, ethyl acetate/hexane) provided the methyl propanoate phenoxyphenyl THP-protected hydroxamate compound (5.6 g, 79%).

Part B: To a solution of the methyl propanoate phenoxyphenyl THP-protected hydroxamate compound of part A (5.6 g, 10 mmol) in methanol (5 mL) was added 4N HCl in dioxane (5 mL, 20 mmol). The resulting solution was stirred at ambient temperature for 0.5 hours. The solvent was removed by rotary evaporation. The residue was dissolved in methylene chloride/ethyl acetate and the compound precipitated with hexane. The precipitate was washed with hexane and dried *in vacuo* to provide the title compound as a white solid (3.8 g, 80%). HRMS (ES<sup>+</sup>) M<sup>+</sup> for C<sub>22</sub>H<sub>25</sub>NO<sub>8</sub>S 464.138. Found: 464.135.

25

Example 103: Preparation of 4-[[4-[(4-fluorophenyl)-thio]phenyl]sulfonyl]tetrahydro-N-hydroxy-2H-pyran-4-carboxamide

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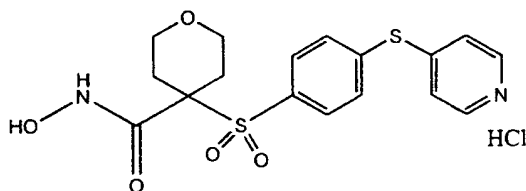
Part A: To a stirred solution under a nitrogen atmosphere of the THP pyranfluoro compound of Example 55, part C, (2.9 g, 7.5 mmol) in N,N-dimethylformamide (25 mL) was added cesium carbonate (4.9 g, 15 mmol), followed by 4-fluoro-thiophenol (1.9 g, 15 mmol). The resulting composition was heated to 95 degrees Celsius for 7 hours. Cesium carbonate was added (1.2 g, 3.8 mmol) after 1 hour of heating and again at two hours. The solution remained at ambient temperature for 9 hours, was concentrated by rotary evaporation, diluted with H<sub>2</sub>O containing 30% brine and extracted with ethyl acetate. The organic layer was washed with half-saturated NaCl and dried over sodium sulfate. The solution was concentrated by rotary evaporation. Chromatography (on silica, ethyl acetate/hexane) followed by reverse phase chromatography (acetonitrile/H<sub>2</sub>O) provided the p-fluoro-phenyl-S-phenyl THP-protected hydroxamate compound (1.9 g, 55%).

Part B: To a solution of the p-fluoro-phenyl-S-phenyl THP-protected hydroxamate compound of part A (1.9 g, 4 mmol) in methanol (5 mL) was added 4N HCl in dioxane (5 mL, 20 mmol). The resulting solution was stirred at ambient temperature for 0.5

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hours. The solvent was removed by rotary evaporation, the residue was dissolved in methylene chloride and precipitated with hexane. The precipitate was and dried *in vacuo* to provide the  
5 title compound as a white solid (1.5 g, 89%). HRMS (ES<sup>+</sup>) M+NH<sub>4</sub><sup>+</sup> for C<sub>18</sub>H<sub>18</sub>NO<sub>5</sub>S<sub>2</sub>F 429.0954. Found: 429.0948.

Example 104: Preparation of Tetrahydro-N-hydroxy-4-  
[[4-(4-pyridinylthio)phenyl]sulfonyl]-  
10 2H-pyran-4-carboxamide,  
monohydrochloride



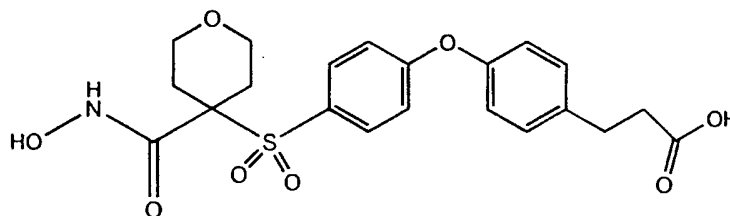
15 Part A: To a stirred solution of the THP pyranfluoro compound of Example 55, Part C, (2.9 g, 7.5 mmol) in N,N-dimethylformamide (20 mL) was added potassium carbonate (2.6 g, 19 mmol), followed by 4-mercaptopyridine (1.7 g, 15 mmol). The resulting  
20 composition was heated to 75 degrees Celsius for 5 hours. Potassium carbonate was added (0.26 g, 1.9 mmol) after 1 hour of heating and again at two hours. The solution remained at ambient temperature for 14 hours. The solution was concentrated by rotary  
25 evaporation, diluted with H<sub>2</sub>O containing 30% brine and extracted with ethyl acetate. The organic layer was washed with half-saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. The solution was concentrated by rotary evaporation.

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Chromatography (on silica, ethyl acetate/hexane) provided the mercaptopyridine THP-protected hydroxamate compound (1.2 g, 33%).

Part B: To a solution of the  
5 mercaptopyridine THP-protected hydroxamate compound of part A (1.2 g, 2.5 mmol) in acetonitrile (20 mL) was added 12.5 N HCl (0.4 mL, 5 mmol), followed by methanol (3 mL). The resulting solution was stirred at ambient temperature for 1 hour. The precipitate  
10 was filtered, washed with methanol followed by ethyl ether and dried *in vacuo* to provide the title compound as a white solid (0.92 g, 86%). HRMS (ES<sup>+</sup>) M+NH<sub>4</sub><sup>+</sup> for C<sub>17</sub>H<sub>18</sub>N<sub>2</sub>O<sub>5</sub>S<sub>2</sub> 395.0735. Found: 395.0734.

15 Example 105: Preparation of 4-[4-[[tetrahydro-4-[(hydroxyamino)carbonyl]-2H-pyran-4-yl]sulfonyl]phenoxy]benzenepropanoic acid

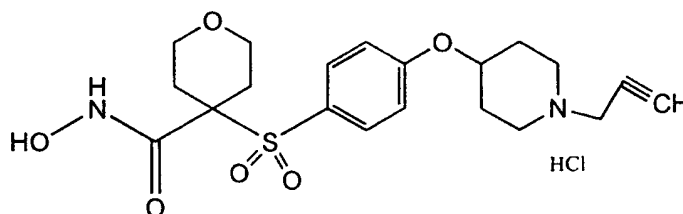


Part A: To a stirred solution of the title compound of Example 102 (0.1 g, 0.2 mmol) in methanol (0.5 mL) was added aqueous 1 M Li(OH)<sub>2</sub> (0.43 mL, 0.43  
25 mmol). After standing at ambient temperature 24 hours, the solution was refluxed 20 hours. The solution was lyophilized to dryness and reverse phase

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chromatography provided the title compound as a white solid (9 mg, 9%). MS (FAB)  $M+Li^+$  for  $C_{21}H_{23}NO_6S$  456. Found: 456.

- 5 Example 106: Preparation of Tetrahydro-N-hydroxy-4-[[4-[[1-(2-propynyl)-4-piperidinyl]-oxy]phenyl]sulfonyl]-2H-pyran-4-carboxamide, monohydrochloride



Part A: To a heat dried three-neck flask under a nitrogen atmosphere was added NaH (1.59g of 60%, 40 mmol) slurried in N,N-dimethylformamide (50 mL). The slurry was chilled to zero degrees Celsius using an ice bath and N-Boc-4-hydroxy piperidine was added (8 g, 40 mmol) followed by a N,N-dimethylformamide rinse (10 mL). The ice bath was removed and the stirred solution permitted to reach ambient temperature over two hours. The stirred solution was again chilled to zero degrees Celsius and the methyl ester compound of Example 55, part C, (10 g, 33 mmol) dissolved in N,N-dimethylformamide (40 mL) was added. The ice bath was removed and the solution stirred at ambient temperature 48 hours. The solution was concentrated by rotary evaporation. The solution was diluted with  $H_2O$  and extracted with

15  
20  
25

-486-

ethyl acetate. The organic layer was dried over sodium sulfate. After chromatography (on silica, ethyl acetate/hexane/methanol), the crude N-Boc methyl ester was treated with 1 N HCl in methanol.

5 The solvent was removed by rotary evaporation. The residue was then dissolved in acetonitrile (21 mL) to which H<sub>2</sub>O was added (21 mLs). Reverse phase chromaatography (on silica, acetonitrile/H<sub>2</sub>O) afforded the purified piperidine methyl ester as the HCl salt

10 (4.9g, 35%).

Part B: To a stirred suspension of the piperidine methyl ester HCl salt of part A (1.8 g, 4 mmol) in acetonitrile (24 mL) and was added potassium carbonate (1.8 g, 13 mmol), followed by propargyl

15 bromide (0.58 mL of 80% solution, 5.2 mmol). The mixture was stirred at ambient temperature for 18 hours. The solution was concentrated by rotary evaporation, diluted with H<sub>2</sub>O and extracted with ethyl acetate. The organic layer was dried over Na<sub>2</sub>SO<sub>4</sub> and

20 concentrated by rotary evaporation. Chromatography (on silica, methylene chloride/methanol) provided the propargyl piperidine methyl ester compound (1.1 g, 63%).

Part C: To a solution of the propargyl

25 piperidine methyl ester compound of part B (1.1 g, 2.7 mmol) in THF (3 mL) was added potassium trimethylsilanoate (0.57 g, 4 mmol). After 5 minutes, THF was added (12 mL), followed by a second addition of THF (15 mL) after 10 more minutes. The

30 resulting solution was stirred at ambient temperature for 18 hours, during which a gel formed. The solvent



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was removed by rotary evaporation, and the residue was diluted with H<sub>2</sub>O and washed with ethyl acetate. The aqueous layer was acidified and chromatographed (on silica, acetonitrile/H<sub>2</sub>O) to provide the desired  
5 propargyl piperidine carboxylic acid after lyophilization (0.64 g, 59%).

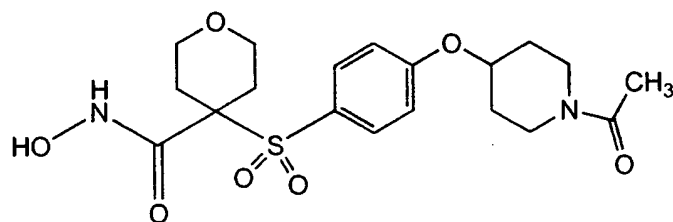
Part D: To a stirred solution of propargyl piperidine carboxylic acid of part C (0.64 g, 1.6 mmol) in N,N-dimethylformamide (5 mL) was added 1-  
10 hydroxybenzotriazole (0.3 g, 2.3 mmol), followed by 1-[3-(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (0.33 g, 1.7 mmol), followed by O-tetrahydro-2H-pyran-2-yl-hydroxylamine (0.57 g, 4.8 mmol). The solution was stirred at ambient  
15 temperature 42 hours, concentrated by rotary evaporation, diluted with H<sub>2</sub>O and extracted with ethyl acetate. The organic layer was washed with saturated sodium bicarbonate, followed by brine and dried over Na<sub>2</sub>SO<sub>4</sub>. The solution was concentrated by rotary  
20 evaporation and chromatographed on reverse phase (on silica, acetonitrile/H<sub>2</sub>O) to provide the title compound as a white solid upon lyophilization (0.2 g, 30%). HRMS (ES<sup>+</sup>) MH<sup>+</sup> for C<sub>20</sub>H<sub>26</sub>N<sub>2</sub>O<sub>6</sub>S 423.159. Found: 423.159.

25

Example 107: Preparation of 4-[[4-[(1-acetyl-4-piperidinyl)oxy]phenyl]-sulfonyl]tetrahydro-N-hydroxy-  
2H-pyran-4-carboxamide

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Part A: Acetic anhydride (1.7 g, 16 mmol) was added to a stirred suspension of the piperidine methyl ester HCl salt of Example 106, part A, (1.8 g, 4 mmol) in pyridine (2 mL). The mixture was stirred at ambient temperature for 20 minutes. The solution was concentrated by rotary evaporation and chromatographed (on silica, ethyl acetate/methanol) to provide the acetyl piperidine methyl ester compound (1.5 g, 83%).

Part B: To a solution of the acetyl piperidine methyl ester compound of part A (1.5 g, 3.3 mmol) in THF (5 mL) was added potassium trimethylsilanoate (0.86 g, 6 mmol). After 5 minutes, THF was added (15 mL), followed by a second addition of THF (15 mL) after 10 more minutes. The resulting solution was stirred at ambient temperature for 18 hours. The precipitate was isolated by filtration to provide the desired acetyl piperidine carboxylic acid (1.5 g, 98%).

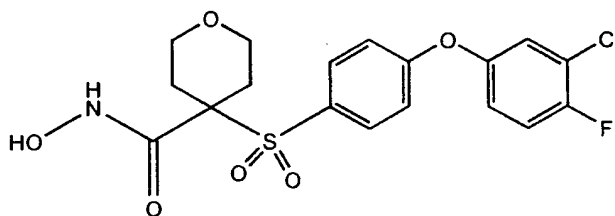
Part C: To a stirred solution of acetyl piperidine carboxylic acid of part B (0.9 g, 2 mmol) in dimethylacetamide (5 mL) was added bromo-tris-pyrrolidino-phosphonium hexafluorophosphate (1 g, 2.3 mmol), followed by 4-methylmorpholine (0.6 g, 6 mmol), followed by aqueous O-tetrahydro-2H-pyran-2-

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yl-hydroxylamine (1.5 mL, 23 mmol) and the solution was stirred at ambient temperature 48 hours.

Reverse-phase chromatography (on silica, H<sub>2</sub>O/acetonitrile) provided title compound as a white solid (0.1 g, 12%). MS (FAB) MH<sup>+</sup> for C<sub>19</sub>H<sub>26</sub>N<sub>2</sub>O<sub>7</sub>S 427. Found: 427.

Example 108: Preparation of 4-[[4-(3-chloro-4-fluorophenoxy)phenyl]sulfonyl]-  
10 tetrahydro-N-hydroxy-2H-  
pyran-4-carboxamide



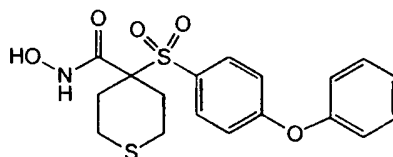
15 Part A: To a stirred solution of the THP  
pyranfluoro compound of Example 55, part C, (3.2 g,  
7.7 mmol ) in N,N-dimethylacetamide (15 mL) was added  
the 3-chloro-4-fluorophenol (1.7 mL, 12 mmol),  
followed by cesium carbonate (5 g, 15.5 mmol). The  
20 reaction was heated at 95 degrees Celsius for 2  
hours. Cesium carbonate (2.5 g, 8 mmol) was added,  
and the reaction was heated at 95 degrees Celsius for  
6 hours. The solution remained at ambient  
temperature for 8 hours. The crude reaction was then  
25 filtered to remove the cesium chloride and  
precipitated product. The filter cake was suspended  
in H<sub>2</sub>O and acidified with HCl to pH=6. After foaming

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ceased, the precipitate was removed by filtration, washed with H<sub>2</sub>O, dissolved in H<sub>2</sub>O/acetonitrile and chromatographed over a reverse phase HPLC column (H<sub>2</sub>O/acetonitrile) to give the 3-chloro-4-fluoro phenoxy THP-protected hydroxamate (1.4 g, 35%).

Part B: To a stirred solution of the 3-chloro-4-fluoro phenoxy THP-protected hydroxamate from part A (1.4 g, 2.7 mmol) in acetonitrile (10 mL) was added 1N aqueous HCl (10 mL). The solution was stirred at ambient temperature for 1 hour. The acetonitrile was evaporated off at ambient temperature under a steady stream of nitrogen until a heavy precipitate formed. The precipitate was filtered and the cake was washed with H<sub>2</sub>O followed by diethyl ether and dried under vacuum, giving the title compound as a white solid (12.5g, 96%). The compound was recrystallized from acetone/hexane, giving white crystals (10.9 g, 86%). HRMS (ES) M+NH<sub>4</sub><sup>+</sup> for C<sub>18</sub>H<sub>19</sub>NO<sub>6</sub>SFCl 447.079. Found: 447.080.

Example 109: Preparation of tetrahydro-N-hydroxy-4-[[4-(4-phenoxy)phenyl] sulfonyl 2H-thiopyran-4-carboxamide



Part A: To a solution of the methylester thiopyran compound of Part C, Example 50 (MW 318, 3

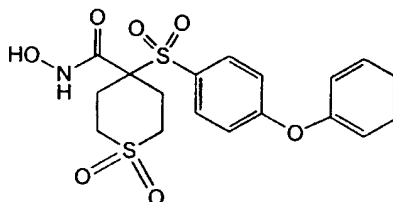
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g, 1.0 equivalents) in N,N-dimethylacetamide (DMA; 40 mL) were added cesium carbonate (12g, 1.5 equivalents) and phenol (1.5g). The mixture was heated to 95 degrees Celsius for 6 hours. After the reaction was cooled to ambient temperature, the reaction mixture was filtered and the N,N-dimethylacetamide was then removed via rotary evaporation. The residue was dissolved in 10% aqueous HCl (100mL) and extracted with ethyl acetate (2x). The ethyl acetate extract was dried over sodium sulfate and removed under reduced pressure to give an oil. The oil was purified on silica gel to give 2 g of methyl ester. The <sup>1</sup>H NMR, MS, and HPLC were consistent with the desired compound.

Part B: To a solution of the methyl ester compound of Part A (MW 392, 2 g) in THF (20 mL) was added potassium trimethylsilanoate (MW 128, 1.6 g, 1.2 equivalents). The mixture stirred 2-3 hours at ambient temperature until a solid precipitate developed. After the hydrolysis was complete, N-methylmorpholine (2 mL) was added followed by PyBrop (2.3 g, 1.2 equivalents). The solution was stirred for 10 minutes, then aqueous hydroxylamine was added and stirring for an additional 2 hours. After complete reaction (2 hours) the solvent was removed via rotary evaporation. The residue was dissolved in water/acetonitrile, made acidic with TFA (pH=2), then purified on prep RPHPLC to give 1 g the title compound as a white solid. The <sup>1</sup>H NMR, MS, and HPLC were consistent with the desired compound. MS (CI) M+H calculated for C<sub>18</sub>H<sub>19</sub>NO<sub>5</sub>S<sub>2</sub>: 393, found 393.

Example 110: Preparation of tetrahydro-N-hydroxy-4-  
[[4-(4-phenoxy)phenyl] sulfonyl 2H-  
sulfonyl pyran-4-carboxamide

5



Part A: Water (50mL) was added to a  
solution of the compound of Example 109, part A, (2  
10 g) in tetrahydrofuran (50mL). To this vigorously  
stirred mixture was added Oxone® (8 g, 3  
equivalents). The course of the reaction was  
monitored by RPHPLC. After 3 hours, water was added  
and the product was extracted with ethyl acetate (100  
15 mL, 2x). The ethyl acetate was dried over sodium  
sulfate. After solvent was removed via reduced  
pressure, 1.8 g of the phenoxy methyl ester compound  
was obtained as a white solid. The <sup>1</sup>H NMR, MS, and  
HPLC were consistent with the desired compound.

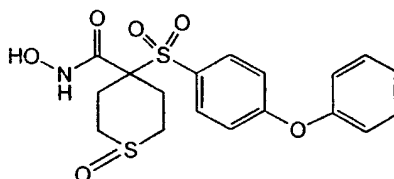
20 Part B: To a solution of the phenoxy  
methyl ester compound of part A (MW 590, 2 g) in  
tetrahydrofuran (20 mL) was added potassium  
trimethylsilanoate (MW 128, 1.2 g, 1.2 equivalents).  
The mixture was stirred 2-3 hours until a solid  
25 precipitate developed. After the hydrolysis was  
complete, N-methylmorpholine (2mL) was added followed  
by PyBrop (2.3 g, 1.2 equivalents). The solution was  
stirred for 10 minutes then aqueous hydroxylamine was

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added and with stirring for an additional 2 hours. After complete reaction, (2 hours) the solvent was removed via rotary evaporation. The residue was dissolved in water/acetonitrile, made acidic with  
5 trifluoroacetic acid (pH=2), then purified on prep RPHPLC to give 500 mg of the title compound as a white solid. The <sup>1</sup>H NMR, MS, and HPLC were consistent with the desired compound. MS (CI) M+H calculated for C<sub>18</sub>H<sub>19</sub>NO<sub>7</sub>S<sub>2</sub>: 425, found 425.

10

Example 111: Preparation of tetrahydro-N-hydroxy-4-  
[[4-(4-phenoxy)phenyl] sulfonyl 2H-  
sulfoxyl pyran-4-carboxamide



15

Part A: To a solution of methyl ester of Example 109, part A, (2 g) in acetic acid/water (25/5mL) was added hydrogen peroxide (2mL, 30%  
20 solution). The course of this vigorously stirred solution was monitored by RPHPLC. After 3 hours, water was added and the product was extracted with ethyl acetate (100 mL, 2x). The ethyl acetate was dried over sodium sulfate. After solvent was removed  
25 via reduced pressure, 2.1 grams of the methylester sulfoxidepyran Phenyl-O-phenyl compound was obtained as a white solid. The <sup>1</sup>H NMR, MS, and HPLC were consistent with the desired compound.

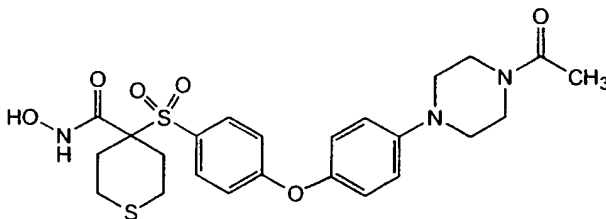
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Part B: To a solution of the methylester sulfoxidepyran Phenyl-O-phenyl compound of Part A (MW 578, 1.8 g) in tetrahydrofuran (25 mL) was added potassium trimethylsilanoate (MW 128, 1.2 g, 1.2 equivalents). The mixture was stirred 2-3 hours until a solid precipitate developed. After the hydrolysis was complete, N-methyl morpholine (2 mL) was added followed by PyBrop (2.3 g, 1.2 equivalents). The solution was stirred for 10 minutes then aqueous hydroxylamine was added, with stirring for an additional 2 hours. After complete reaction (12 hours) the solvent was removed via rotary evaporation. The residue was dissolved in water/acetonitrile, made acidic with trifluoroacetic acid (pH=2), then purified on prep RPHPLC to give 500 milligrams of the title compound as a white solid. The <sup>1</sup>H NMR, MS, and HPLC were consistent with the desired compound. MS (CI) M+H calculated for C<sub>18</sub>H<sub>19</sub>NO<sub>6</sub>S<sub>2</sub>: 409, found 409.

20

Example 112: Preparation of tetrahydro-N-hydroxy-4-  
[[4-(1-acetyl-4-(4-piperazine-  
phenoxy)phenyl] sulfonyl 2H-  
thiopyran-4-carboxamide

25



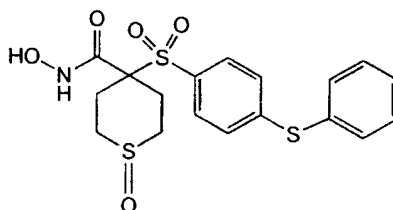


Part A: To a solution of the methylester thiopyran compound of Example 50, part C, (MW 318, 5 g, 1.0 equivalents) in N,N-dimethylacetamide (70mL) were added cesium carbonate (MW 5.5g, 1.5  
5 equivalents), tetrabutylammonium fluoride (2 mL, 2 M in THF) and 1-acetyl-4-(4-hydroxyphenyl)piperazine (4.9 g). The mixture was stirred and heated at 90 degrees Celsius for 6 hours. The reaction mixture was filtered and the N,N-dimethylacetamide was then  
10 removed via rotary evaporation. The residue was dissolved in water (100mL) and extracted with ethyl acetate (2x). The ethyl acetate was dried over sodium sulfate and removed under reduced pressure to give an oil. The oil was purified on silica gel to  
15 give 3 g of methyl ester. The <sup>1</sup>H NMR, MS, and HPLC were consistent with the desired compound.

Step B: To a solution of the methyl ester compound of Part A (MW 433, 3 g) in tetrahydrofuran (50 mL) was added potassium trimethylsilanoate (MW  
20 128, 0.9 g, 1.2 equivalents). The mixture was stirred 2-3 hours until a solid precipitate developed. After the hydrolysis was complete N-methyl morpholine (2 mL) was added followed by PyBrop (3.5 g, 1.2 equivalents). The solution was stirred  
25 for 10 minutes then aqueous hydroxylamine was added with stirring for an additional 2 hours. After complete reaction (2 hours) the solvent was removed via rotary evaporation. The residue was dissolved in water/acetonitrile, made acidic with trifluoroacetic  
30 acid (pH=2), then purified on prep RPHPLC to give 1.2 g of the title compound as a white solid. The <sup>1</sup>H NMR,

MS, and HPLC were consistent with the desired compound. MS (CI) M+H calculated for  $C_{24}H_{29}N_3O_6S_2$ : 519, found 519.

- 5 Example 113: Preparation of tetrahydro-N-hydroxy-4-  
[[4-(4-thiophenoxy)phenyl] sulfonyl 2H-  
thiopyran-4-carboxamide



10

Part A: To a solution of the methylester thiopyran compound of Example 50, part C, (5 g.) in acetic acid (40mL) was added water/hydrogen peroxide (8 mL, 4 mL/4 mL, 30% solution). The course  
15 of this vigorously stirred solution was monitored by RPHPLC. After 3 hours at ambient temperature, water was added and the product was extracted with ethyl acetate (100 mL, 2x). The ethyl acetate was dried over sodium sulfate. After solvent was removed via  
20 reduced pressure 4.5 g of the methylester sulfoxidepyran Ph-p-F was obtained as a white solid. The  $^1H$  NMR, MS, and HPLC were consistent with the desired compound.

Part B: To a solution of the methylester  
25 sulfoxidepyran Ph-p-F of Part A (MW 318, 5 g, 1.0 equivalents) in DMA (70 mL) were added cesium carbonate (MW 4.5g, 1.1 equivalents) and thiophenol

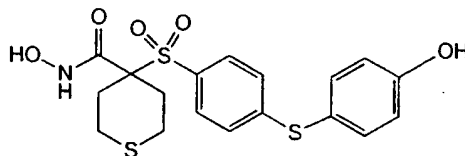
-497-

(1.5 g, 1.05 equivalents). The mixture was stirred 2 hours at room temperature. The reaction mixture was filtered and the N,N-dimethylacetamide was then removed via rotary evaporation. The residue was  
5 dissolved in water (100 mL) and extracted with ethyl acetate (2x). The ethyl acetate was dried over sodium sulfate and removed under reduced pressure to give an oil. The oil was purified on prep RPHPLC to give 2 g of methyl ester sulfoxidepyran Phenyl-S-Ph  
10 compound. The <sup>1</sup>H NMR, MS, and HPLC were consistent with the desired compound.

Part C: To a solution of the methyl ester sulfoxidepyran Phenyl-S-Ph of Part B (MW 590, 5 g) in tetrahydrofuran (100 mL) was added potassium  
15 trimethylsilanoate (MW 128, 1.5 g, 2 equivalents). The mixture was stirred 2-3 hours at ambient temperature until a solid precipitate developed. After the hydrolysis was complete, N-methyl morpholine (6 mL) was added followed by PyBrop (4 g,  
20 1.1 equivalents). The solution was stirred for 10 minutes then aqueous hydroxylamine was added with stirring for an additional 2 hours. After complete reaction (12 hours), the solvent was removed via rotary evaporation. The residue was dissolved in  
25 water/acetonitrile, made acidic with trifluoroacetic acid (pH=2), then purified on prep RPHPLC to give 1.9 g of the title compound as a white solid. The <sup>1</sup>H NMR, MS, and HPLC were consistent with the desired compound. MS (CI) M+H calculated for C<sub>18</sub>H<sub>19</sub>NO<sub>5</sub>S<sub>3</sub>: 425,  
30 found 425.

Example 114: Preparation of tetrahydro-N-hydroxy-  
4-[[4-[4-(4-hydroxyphenyl)thiophenoxy)-  
phenyl] sulfonyl 2H-thiopyran-  
4-carboxamide

5



Part A: To a solution of the title  
compound of Example 50 (MW 402, 5 g, 1.0 equivalent)  
10 in N,N-dimethylacetamide (70 mL) was added the 4-  
hydroxythiophenol (MW 126, 1.6 g, 1.3 equivalents)  
followed by potassium carbonate (MW 138, 5 g, 2.0  
equivalents). The reaction was heated at 65 degrees  
Celsius for 3 hours, until HPLC indicated the  
15 reaction had finished. The reaction mixture was  
filtered, the N,N-dimethylacetamide was removed in  
vacuo. The residue was dissolved in water (100mL) and  
extracted with ethyl acetate (2x). The ethyl acetate  
was dried over sodium sulfate and removed under  
20 reduced pressure to give the p-OH thiophenoxy  
compound as a crude oil. The <sup>1</sup>H NMR, MS, and HPLC  
were consistent with the desired compound.

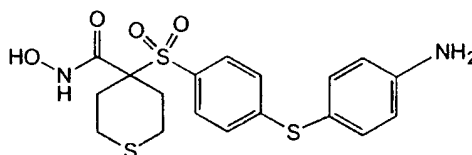
Part B: The crude p-OH thiophenoxy  
compound from Part A was stirred in HCl/dioxane (50  
25 mL) for 2 hours. The solvent was removed and the  
residue was dried and dissolved in  
water/acetonitrile, made acidic with trifluoroacetic  
acid (pH=2), then purified on prep RPHPLC to give 2.1

-499-

g of the title compound as a yellow solid. The  $^1\text{H}$  NMR, MS, and HPLC were consistent with the desired compound. MS (CI) M+H calculated for  $\text{C}_{18}\text{H}_{19}\text{NO}_5\text{S}_3$ : 425, found 425.

5

Example 115: Preparation of tetrahydro-N-hydroxy-4-  
[[4-[4-aminophenyl]thiophenoxy]phenyl]  
sulfonyl 2H-thiopyran-4-carboxamide



10

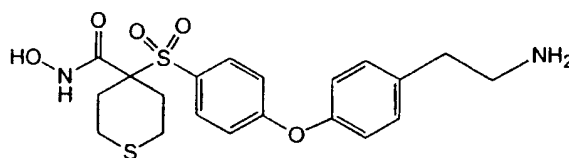
Part A: To a solution of the title compound of Example 50 (MW 402, 5 g, 1.0 equivalents) in N,N-dimethylacetamide (70 mL) was added the 4-  
15 aminothiophenol (MW 126, 1.6 g, 1.3 equivalents) followed by potassium carbonate (MW 138, 5 g, 2.0 equivalents). The reaction was heated at 65 °C for 3 hours, until HPLC indicated the reaction had finished. The reaction mixture was filtered, and the  
20 N,N-dimethylacetamide was removed *in vacuo*. The residue was dissolved in water (100mL) and extracted with ethyl acetate (2x). The ethyl acetate was dried over sodium sulfate and removed under reduced pressure to give the p-NH<sub>2</sub> thiophenoxy compound as a  
25 crude oil. The  $^1\text{H}$  NMR, MS, and HPLC were consistent with the desired compound.

Part B: The crude p-NH<sub>2</sub> thiophenoxy compound of Part A was stirred in HCl/dioxane (50 mL)

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for 2 hours. The solvent was removed and the residue was dried and dissolved in water/acetonitrile, made acidic with trifluoroacetic acid (pH=2), then purified on prep RPHPLC to give 2.1 g of the title compound as a yellow solid. The <sup>1</sup>H NMR, MS, and HPLC were consistent with the desired compound. MS (CI) M+H calculated for C<sub>18</sub>H<sub>20</sub>N<sub>2</sub>O<sub>4</sub>S, C<sub>2</sub>HF<sub>3</sub>O<sub>2</sub>: 538, found 538.

Example 116: Preparation of tetrahydro-N-hydroxy-4-  
[[4-[4-(tyramine)phenoxy]phenyl]  
sulfonyl 2H-thiopyran-4-carboxamide



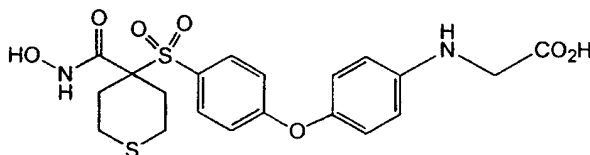
Step A: To a solution of title compound of Example 50 (MW 402, 5 g, 1.0 equivalents) in N,N-dimethylacetamide (50mL) was added the tryptamine (3 g, 2 equivalents), followed by cesium carbonate (10 g, 2.0 equivalents). The reaction was heated at 95 degrees Celsius for 5 hours, until HPLC indicated the reaction had finished. The reaction mixture was filtered, the N,N-dimethylacetamide was removed in vacuo. The solvent was removed and the residue was dried and dissolved in water/acetonitrile, made acidic with trifluoroacetic acid (TFA; pH=2), then purified on prep RPHPLC to give 2.5 g of the crude methyl ester as a yellow solid. The <sup>1</sup>H NMR, MS, and HPLC were consistent with the desired compound.

-501-

Step B: The crude methyl ester from reaction Step A was stirred in aqueous HCl (50 mL) for 1 hour. The solvent was removed and the residue was dried and dissolved in water/acetonitrile, made  
5 acidic with TFA (pH=2), then purified on prep RPHPLC to give 2.2 g of yellow foam solid as the trifluoroacetic acid salt of the title compound. The <sup>1</sup>H NMR, MS, and HPLC were consistent with the desired compound. MS (CI) M+H calculated for C<sub>20</sub>H<sub>24</sub>N<sub>2</sub>O<sub>5</sub>S<sub>2</sub>  
10 C<sub>2</sub>HF<sub>3</sub>O<sub>2</sub>: 550, found 550.

Example 117: Preparation of tetrahydro-N-hydroxy-4-  
[[4-[4-hydroxyphenyl glycine)]phenyl]  
sulfonyl 2H-thiopyran-4-carboxamide

15



Step A: To a solution of the title compound of Example 50 (MW 402, 5 g, 1.0 equivalents)  
20 in N,N-dimethylacetamide (50 mL) was added hydroxyphenylglycine (3 g, 2 equivalents), followed by cesium carbonate (10g, 2.0 equivalents). The reaction was heated at 95 degrees Celsius for 5 hours, until HPLC indicated the reaction had  
25 finished. The reaction mixture was filtered, the N,N-dimethylacetamide was removed *in vacuo*. The solvent was removed, the residue was dried and dissolved in water/acetonitrile, made acidic with

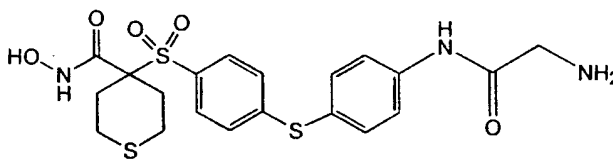
-502-

trifluoroacetic acid (pH=2), then purified on prep RPHPLC to give 2.0 g of the crude methyl ester as a tan solid. The  $^1\text{H}$  NMR, MS, and HPLC were consistent with the desired compound.

5                    Step B: The crude methyl ester from reaction Step A was stirred in aqueous HCl (50 mL) for 1 hour. The solvent was removed and the residue was dried and dissolved in water/acetonitrile, made acidic with trifluoroacetic acid (pH=2), then  
10 purified on prep RPHPLC to give 2.2 g of tan foam/solid as the trifluoroacetic acid salt of the title compound. The  $^1\text{H}$  NMR, MS, and HPLC were consistent with the desired compound. MS (CI) M+H calculated for  $\text{C}_{20}\text{H}_{22}\text{N}_2\text{O}_7\text{S}_2$ ,  $\text{C}_2\text{HF}_3\text{O}_2$ : 580, found 580.

15

Example 118: Preparation of tetrahydro-N-hydroxy-4-  
[[4-[4-hydroxyphenyl glycine)]phenyl]  
sulfonyl 2H-thiopyran-4-carboxamide



20

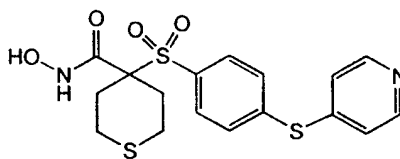
Step A: A solution of the title compound of Example 115 (MW 518, 2.5 g, 1.0 equivalents) in THF (25 mL) and N-Boc N-hydroxysuccinyl glycine (2.1  
25 g, 2 equivalents) containing N-methylmorpholine (2 mL) and 4-dimethylaminopyridine (250 mg) was stirred for 12 hours. After RPHPLC indicated complete reaction at this time, the solvent was removed under



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reduced pressure to give an oil. Hydrochloric acid 10% aqueous solution was added with stirring for an additional 1-2 hours. The solution was then purified on prep RPHPLC to give 1.2 g of white foam/solid as the trifluoroacetic acid salt. The  $^1\text{H}$  NMR, MS, and HPLC were consistent with the desired compound. The solid was dried under reduced pressure, then suspended in ethyl ether followed by addition of 4N HCl/dioxane (20 mL). The HCl salt was filtered and washed with ethyl ether to give the title compound as a tan solid (1.1 g). The  $^1\text{H}$  NMR, MS, and HPLC were consistent with the desired compound. MS (CI) M+H calculated for  $\text{C}_{20}\text{H}_{23}\text{N}_3\text{O}_5\text{S}_3$ ,  $\text{C}_2\text{HF}_3\text{O}_2$ : 595, found 595.

Example 119: Preparation of tetrahydro-N-hydroxy-4-[[4-(4-pyridinylthio)phenyl]sulfonyl]-2H-thiopyran-4-carboxamide, monohydrochloride



20

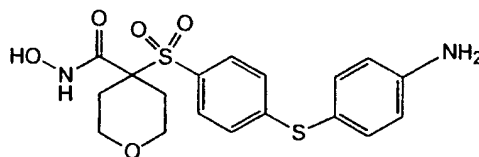
Step A: To a solution of the title compound of Example 50 (MW 402, 5 g, 1.0 equivalents) in N,N-dimethylacetamide (50 mL) were added 4-thiopyridine (3 g, 2 equivalents), followed by cesium carbonate (10g, 2.0 equivalents). The reaction mixture was heated at 75 degrees Celsius for 5 hours, until HPLC indicated the reaction had finished. The

-504-

reaction mixture was filtered, and the N,N-dimethylacetamide was removed *in vacuo*. The residue was dried and dissolved in water/acetonitrile, made acidic with trifluoroacetic acid (pH=2), then  
5 purified on prep RPHPLC to give 2.0 g of the crude -S-pyridyl THP-protected thiopyran compound as a brown solid. The <sup>1</sup>H NMR, MS, and HPLC were consistent with the desired compound.

Step B: The -S-pyridyl THP-protected  
10 thiopyran compound from Step A was stirred in aqueous HCl (50 mL) for 1 hour. The solvent was removed and the residue was dried and dissolved in water/acetonitrile, made acidic with trifluoroacetic acid (pH=2), then purified on prep RPHPLC to give 1.8  
15 g of tan foam/glass as the trifluoroacetic acid salt of the title compound. The <sup>1</sup>H NMR, MS, and HPLC were consistent with the desired compound. MS (CI) M+H calculated for C<sub>17</sub>H<sub>18</sub>N<sub>2</sub>O<sub>4</sub>S<sub>3</sub> HCl: 447, found 447.

20 Example 120: Preparation of 4-[[4-[(4-aminophenyl)thio]phenyl]-sulfonyl]tetrahydro-N-hydroxy-2H-pyran-4-carboxamide



25

Step A: To a solution of the title compound of Example 55 (MW 387, 5 g, 1.0 equivalents)

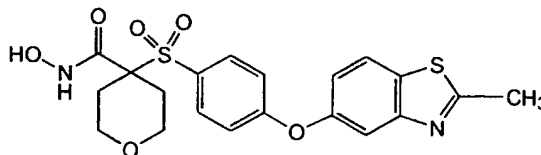
-505-

in N,N-dimethylacetamide (50 mL) were added the 4-aminothiophenol (3 g, 2 equivalents) followed by potassium carbonate (10g, 2.0 equivalents). The reaction was heated at 60 degrees Celsius for 5  
5 hours, until HPLC indicated the reaction had finished. The reaction mixture was filtered, the DMA was removed in vacuo. The solvent was removed and the residue was dried and dissolved in water/acetonitrile, made acidic with trifluoroacetic  
10 acid (pH=2), then purified on prep RPHPLC to give 2.0 g of the crude 4-amino-S-Ph THP-protected thiopyran as a brown solid. The <sup>1</sup>H NMR, MS, and HPLC were consistent with the desired compound.

Step B: The 4-amino-S-Ph THP-protected  
15 thiopyran compound of Step A was stirred in aqueous HCl (50 mL) for 1 hour. The solvent was removed and the residue was dried and dissolved in water/acetonitrile, made acidic with trifluoroacetic acid (pH=2), then purified on prep RPHPLC to give 1.4  
20 g of tan foam/glass as the trifluoroacetic acid salt of the title compound. The <sup>1</sup>H NMR, MS, and HPLC were consistent with the desired compound. MS (CI) M+H calculated for C<sub>18</sub>H<sub>20</sub>N<sub>2</sub>O<sub>5</sub>S<sub>2</sub>: 408, found 408.

25 Example 121: Preparation of tetrahydro-N-hydroxy-4-  
[[4-[(2-methyl-5-benzothiazolyl)-  
oxy]phenyl]sulfonyl]-  
2H-pyran-4-carboxamide

-506-



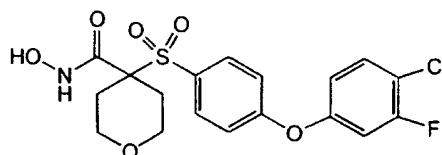
Step A: To a solution of the title compound of Example 55 (MW 387, 10g, 1.0 equivalents) in DMA (50mL) were added hydroxymethyl benzothiazole (8 g, 1.5 equivalents) followed by cesium carbonate (20 g, 2.0 equivalents). The reaction was heated at 90 degrees Celsius for 5 hours, until HPLC indicated the reaction had finished. The reaction mixture was cooled then filtered, the N,N-dimethylacetamide was discarded. The filter cake was placed in 10% aqueous HCl and stirred for 30 minutes to remove the cesium salts. The desired solid separated out of solution as a gum. This gum was dissolved in ethyl acetate (100 mL) and was washed with water and dried over sodium sulfate. The solvent was removed *in vacuo* to give an oil that was dissolved in water/acetonitrile, made acidic with trifluoroacetic acid (pH=2), then purified on prep RPHPLC to give the 2-methyl-5-benzothiazolyloxy compound. The <sup>1</sup>H NMR, MS, and HPLC were consistent with the desired compound.

Step B: The 2-methyl-5-benzothiazolyloxy compound of Step A was stirred in aqueous HCl (20mL)/acetonitrile(20mL) for 1 hour. The solvent was concentrated and the solid that separated was filtered to give 6.5 g of the title compound. The <sup>1</sup>H NMR, MS, and HPLC were consistent with the desired

-507-

compound. MS (CI) M+H calculated for  $C_{20}H_{20}N_2O_6S_2$ : 448, found 448.

Example 122: Preparation of 4-[[4-(4-chloro-3-  
5 fluorophenoxy)phenyl]sulfonyl]-  
tetrahydro-N-hydroxy-2H-pyran-4-  
carboxamide



10

Step A: To a solution of the title compound of Example 55 (MW 387, 10 g, 1.0 equivalents) in N,N-dimethylacetamide (50 mL) were  
15 added 4-chloro-3-fluorophenol (7 g, 1.4 equivalents) followed by cesium carbonate (20g, 2.0 equivalents). The reaction was heated at 90 degrees Celsius for 5 hours, until HPLC indicated the reaction had finished. The reaction mixture was cooled then  
20 filtered, the DMA was discarded. The filter cake was placed in 10% aqueous HCl and stirred for 30 minutes to remove the cesium salts. The desired 4-chloro-3-fluorophenoxy compound (11 g) separated out of solution and was filtered. The  $^1H$  NMR, MS, and HPLC  
25 were consistent with the desired compound.

Step B: The 4-chloro-3-fluorophenoxy compound (3.4 g) of Step A was stirred in aqueous HCl (20 mL)/ acetonitrile(20 mL) for 1 hour. The solvent

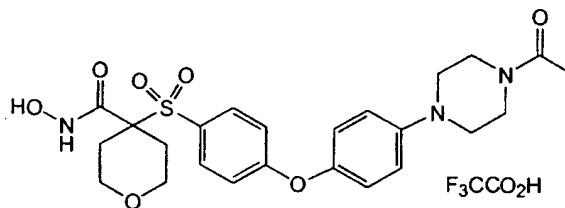
-508-

was concentrated and the solid that separated was filtered to give 2.0 g of the title compound. The  $^1\text{H}$  NMR, MS, and HPLC were consistent with the desired compound. MS (CI)  $\text{M}+\text{H}$  calculated for  $\text{C}_{18}\text{H}_{17}\text{ClFNO}_6\text{S}$ :

5 429, found 429.

Example 123: Preparation of 4-[[4-[4-(4-acetyl-1-piperazinyl)phenoxy]phenyl]sulfonyl]-tetrahydro-N-hydroxy-2H-pyran-4-

10 carboxamide, trifluoroacetic acid salt



Step A: To a solution of the title

15 compound of Example 55 (MW 387, 5 g, 1.0 equivalents) in DMA (50 mL) were added 1-acetyl-4-(4-hydroxy-phenyl)piperazine (3 g, 2 equivalents) followed by cesium carbonate (10g, 2.0 equivalents). The reaction was heated at 90 degrees Celsius for 5

20 hours, until HPLC indicated the reaction had finished. The reaction mixture was filtered, the DMA was removed *in vacuo*. The residue was dissolved in water/acetonitrile, made acidic with TFA (pH=2), then purified on prep RPHPLC to give 3.1 g of the crude 4-

25 acetyl-1-piperazinylphenoxy compound as a brown solid. The  $^1\text{H}$  NMR, MS, and HPLC were consistent with the desired compound.

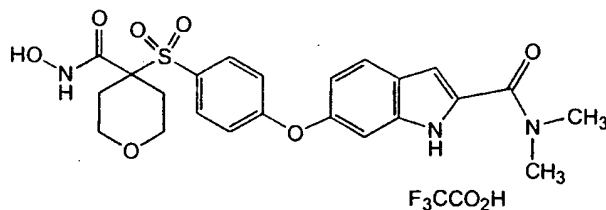
-509-

Step B: The 4-acetyl-1-piperazinyloxy compound from reaction Step A was stirred in aqueous HCl (50 mL) for 1 hour. The solvent was removed and the residue was dried and dissolved in

5 water/acetonitrile, made acidic with TFA (pH=2), then purified on prep RPHPLC to give 2.0 g of tan foam as the trifluoroacetic acid salt of the title compound. The <sup>1</sup>H NMR, MS, and HPLC were consistent with the desired compound. MS (CI) M+H calculated for C<sub>24</sub>H<sub>29</sub>N<sub>3</sub>O<sub>7</sub>S

10 C<sub>2</sub>HF<sub>3</sub>O<sub>2</sub>: 617, found 617.

Example 124: Preparation of N,N-dimethyl-5-[4-  
[[tetrahydro-4-[(hydroxyamino)-  
carbonyl]-2H-pyran-4-yl]sulfonyl]-  
15 phenoxy]-1H-indole-2-carboxamide,  
trifluoroacetic acid salt



20 Step A: To a solution of the title compound of Example 55 (MW 387, 5g, 1.0 equivalents) in DMA (50 mL) were added the 5-hydroxy-2-indole dimethylcarboxylate (3 g, 2 equivalents) followed by Cs<sub>2</sub>CO<sub>3</sub> (10 g, 2.0 equivalents). The reaction was

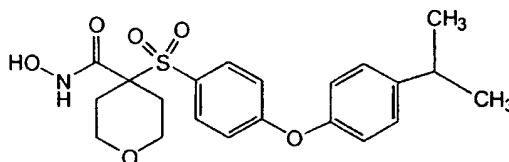
25 heated at 90 degrees Celsius for 5 hours, until HPLC indicated the reaction had finished. The reaction mixture was filtered, the DMA was removed in vacuo.

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The residue was dissolved in water/acetonitrile, made acidic with TFA (pH=2), then purified on prep RPHPLC to give 2.1 g of the crude THP-protected pyran hydroxamate compound as a brown solid. The <sup>1</sup>H NMR, MS, and HPLC were consistent with the desired compound.

Step B: The THP-protected pyran hydroxamate compound from Step A was stirred in aqueous HCl (50 mL) for 1 hour. The solvent was removed and the residue was dried and dissolved in water/acetonitrile, made acidic with TFA (pH=2), then purified on prep RPHPLC to give 1.5 g of tan solid as the trifluoroacetic acid salt of the title compound. The <sup>1</sup>H NMR, MS, and HPLC were consistent with the desired compound. MS (CI) M+H calculated for C<sub>23</sub>H<sub>25</sub>N<sub>3</sub>O<sub>7</sub>S: 487, found 487.

Example 125: Preparation of tetrahydro-N-hydroxy-4-  
[[4-[4-(1-methylethyl)phenoxy]phenyl]-  
sulfonyl]-2H-pyran-4-carboxamide



Step A: To a solution of the title compound of Example 55 (MW 387, 5 g, 1.0 equivalents) in DMA (50 mL) was added the 4-isopropylphenol (3 g, 2 equivalents), followed by cesium carbonate (10 g, 2.0 equivalents). The reaction mixture was heated at



-511-

90 degrees Celsius for 8 hours, until HPLC indicated the reaction had finished. The reaction mixture was filtered, the DMA portion was discarded. The filter cake was placed in 10% aqueous HCl and stirred for 30 minutes to remove the cesium salts. The solid (3.5 g) isopropylphenoxyphenyl THP-protected hydroxamate separated and was filtered. The <sup>1</sup>H NMR, MS, and HPLC were consistent with the desired compound.

Step B: Into a stirred solution of aqueous HCl (20 mL) and acetonitrile (20 mL) was added the crude isopropyl-phenoxyphenyl THP-protected hydroxamate from Step A and the resulting mixture was stirred for 1-2 hours. The solvent was concentrated via a stream of nitrogen over the surface of the solution. The solid was filtered and dried to give 2.2 g of the title compound as a tan solid. The <sup>1</sup>H NMR, MS, and HPLC were consistent with the desired compound. MS (CI) M+H calculated for C<sub>21</sub>H<sub>25</sub>NO<sub>6</sub>S: 419, found 419.

20

Example 126: Preparation of Resin II:

Step 1: Attachment of Compound  
of Example 55, Part D, to Resin I

A 500 mL round-bottomed flask was charged with of resin I [Floyd et al., *Tetrahedron Lett.* 1996, 37, 8045-8048] (8.08 g, 9.7 mmol) and 1-methyl-2-pyrrolidinone (50 mL). A magnetic stirring bar was added, and the resin slurry slowly stirred. A separate solution of the compound of Part D, Example 55 (5.58 g, 19.4 mmol) in 1-methyl-2-pyrrolidinone (35

-512-

mL) was added to the slurry followed by addition of benzotriazole-1-yl-oxy-tris-pyrrolidino-phosphonium hexafluorophosphate (10.1 g, 19.4 mmol) in one portion. Once the hexafluorophosphate salt had  
5 dissolved, 4-methylmorpholine (4.26 mL, 39 mmol) was added dropwise. The reaction slurry was stirred at room temperature for 24 hours, then the resin was collected in a sintered-disc funnel and washed with N,N-dimethylformamide, methanol, methylene chloride  
10 and diethyl ether (3x30 mL each solvent). The resin was dried *in vacuo* to yield 10.99 g polymer-bound hydroxamate as a tan polymeric solid. Theoretical loading on polymer was 0.91 mmol/g. FTIR microscopy showed bands at 1693 and 3326  $\text{cm}^{-1}$  indicative of the  
15 hydroxamate carbonyl and nitrogen-hydrogen stretches, respectively.

#### Step 2: Preparation of Resin III:

##### Reaction of Resin II With

##### 20 Nucleophiles

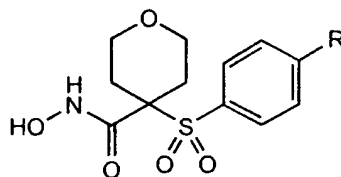
Resin II (50 mg, 0.046 mmol) was weighed into an 8 mL glass vial, and a 0.5 M solution of a nucleophile in 1-methyl-2-pyrrolidinone (1 mL) was added to the vessel. In the case of phenol and  
25 thiophenol nucleophiles, cesium carbonate (148 mg, 0.46 mmol) was added, and in the case of substituted piperazine nucleophiles, potassium carbonate (64 mg, 0.46 mmol) was added. The vial was capped and heated to 70 to 155 degrees Celsius for 24-48 hours, then  
30 cooled to room temperature. The resin was drained and washed with 1-methyl-2-pyrrolidinone, 1-methyl-2-

pyrrolidinone/water (1:1), water, 10% acetic acid/water, methanol, and methylene chloride (3x3 mL each solvent).

Step 3: Cleavage of Hydroxamic Acids  
From The Polymer-Support

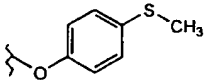
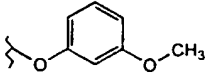
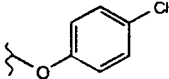
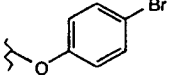
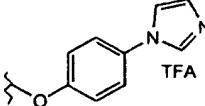
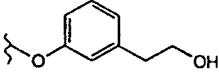
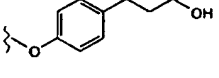
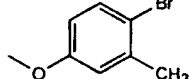
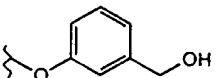
Resin III was treated with a trifluoroacetic acid/ water mixture (19:1, 1 mL) for 1 hour at room temperature. During that time, the resin became a deep red color. The resin was then drained and washed with trifluoroacetic acid/water (19:1) and methylene chloride (2x1 mL each solvent), collecting the combined filtrates in a tared vial. The volatiles were removed *in vacuo*, then a toluene/methylene chloride mixture (2 mL each) was added to the residue. The mixture was again concentrated *in vacuo*. The product was characterized by electrospray mass spectroscopy.

20           The following hydroxamic acids were synthesized from resin II using the conditions of Step 2 with the indicated nucleophile, followed by release from the polymer using Step 3 reaction conditions.

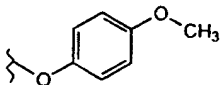
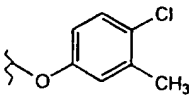
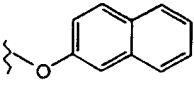
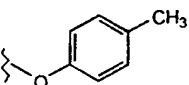
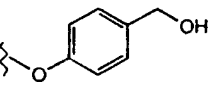
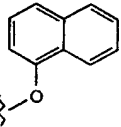
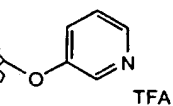
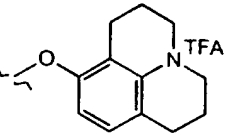
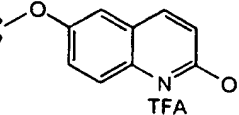


Example Number	R	Nucleophile	MS (ES)
			m/z
126-1		4'-hydroxy-2'- methylacetophenone	451 (M+NH <sub>4</sub> )
126-2		5,6,7,8-tetrahydro- 2-naphthol	455 (M+NH <sub>4</sub> )
126-3		3,4-dichlorophenol	462 (M+NH <sub>4</sub> )
126-4		4-hydroxyphenethyl alcohol	439 (M+NH <sub>4</sub> )
126-5		4-hydroxy diphenylmethane	485 (M+NH <sub>4</sub> )
126-6		4-phenylphenol	471 (M+NH <sub>4</sub> )

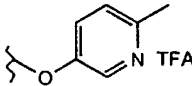
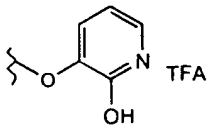
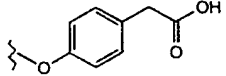
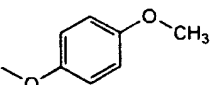
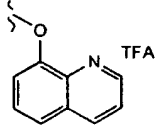
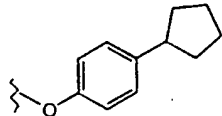
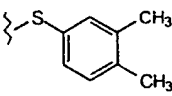
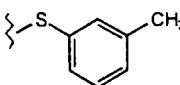
-515-

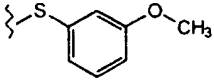
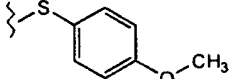
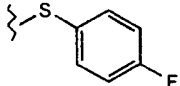
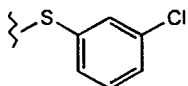
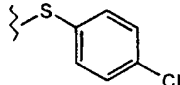
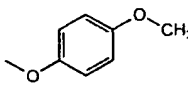
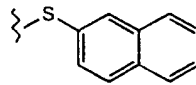
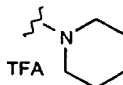
126-7		4-(methylthio)phenol	441 (M+NH <sub>4</sub> )
126-8		3-methoxyphenol	425 (M+NH <sub>4</sub> )
126-9		4-chlorophenol	429 (M+NH <sub>4</sub> )
126-10		4-bromophenol	590 (M+Cs)
126-11		4-(imidazol-1-yl)- phenol	444 (M+H)
126-12		3-hydroxyphenethyl alcohol	439 (M+NH <sub>4</sub> )
126-13		3-(4-hydroxy- phenyl)-1-phenol	453 (M+NH <sub>4</sub> )
126-14		4-bromo-3- methylphenol	487 (M+NH <sub>4</sub> )
126-15		3-hydroxybenzyl alcohol	425 (M+NH <sub>4</sub> )

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126-16		4-methoxyphenol	425 (M+NH <sub>4</sub> )
126-17		4-chloro-3-methylphenol	558 (M+Cs)
126-18		2-naphthol	560 (M+Cs)
126-19		p-cresol	409 (M+NH <sub>4</sub> )
126-20		4-hydroxybenzyl alcohol	408 (M+H)
126-21		1-naphthol	445 (M+NH <sub>4</sub> )
126-22		3-hydroxypyridine	379 (M+H)
126-23		8-hydroxyjulolidine	473 (M+H)
126-24		2,6-quinolinediol	445 (M+H)

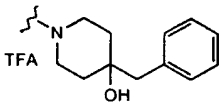
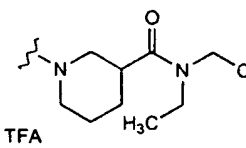
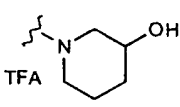
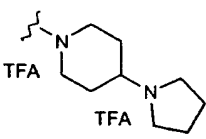
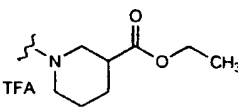
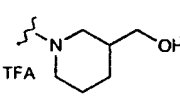
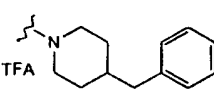
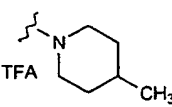
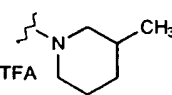
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126-25		5-hydroxy-2-methylpyridine	393 (M+H)
126-26		2,3-dihydroxypyridine	412 (M+H)
126-27		4-hydroxyphenyl acetic acid	453 (M+NH <sub>4</sub> )
126-28		4-amino-m-cresol	407 (M+H)
126-29		8-quinolinol	429 (M+H)
126-30		4-cyclopentylphenol	463 (M+NH <sub>4</sub> )
126-31		3,4-dimethylthiophenol	439 (M+NH <sub>4</sub> )
126-32		m-thiocresol	425 (M+NH <sub>4</sub> )

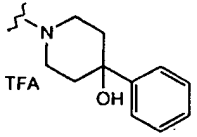
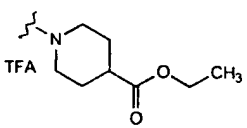
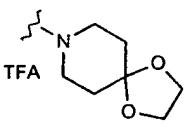
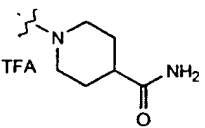
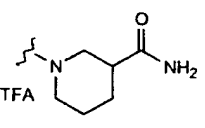
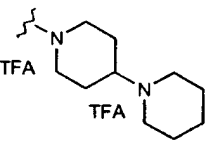
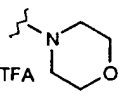
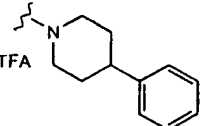
126-33		3-methoxythiophenol	441 (M+NH <sub>4</sub> )
126-34		4-methoxythiophenol	441 (M+NH <sub>4</sub> )
126-35		4-fluorothiophenol	429 (M+NH <sub>4</sub> )
126-36		3-chlorothiophenol	445 (M+NH <sub>4</sub> )
126-37		4-chlorothiophenol	445 (M+NH <sub>4</sub> )
126-38		4-aminothiophenol	426 (M+NH <sub>4</sub> )
126-39		2-naphthalenethiol	461 (M+NH <sub>4</sub> )
126-40		piperidine	



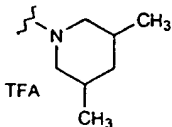
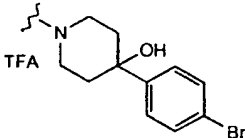
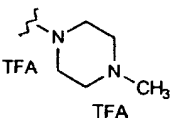
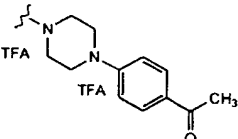
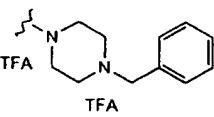
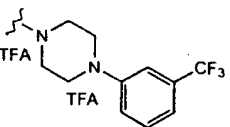
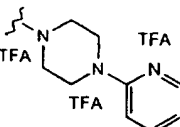
-519-

126-41		4-benzyl-4-hydroxypiperidine	475 (M+H)
126-42		nipecotamide	468 (M+H)
126-43		3-hydroxypiperidine	385 (M+H)
126-44		4-(1-pyrrolidinyl)-piperidine	438 (M+H)
126-45		ethyl nipecotate	441 (M+H)
126-46		3-piperidinyl-methanol	512 (M+TFA)
126-47		4-benzylpiperidine	459 (M+H)
126-48		4-methylpiperidine	383 (M+H)
126-49		3-methylpiperidine	383 (M+H)

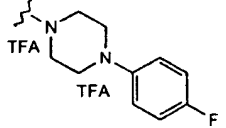
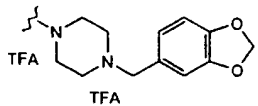
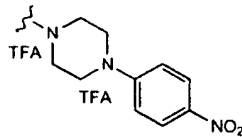
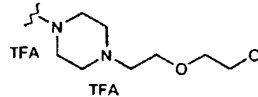
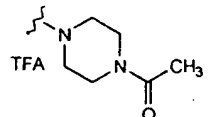
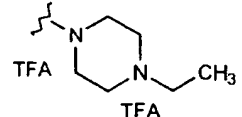
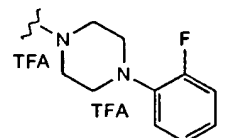
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126-50		4-hydroxy-4-phenylpiperidine	461 (M+H)
126-51		ethyl isonipecotate	441 (M+H)
126-52		1,4-dioxaspiro(4,5)decane	427 (M+H)
126-53		isonipecotamide	412 (M+H)
126-54		nipecotamide	412 (M+H)
126-55		4-piperidino-piperidine	452 (M+H)
126-56		morpholine	388 (M+NH <sub>4</sub> )
126-57		4-phenylpiperidine	445 (M+H)

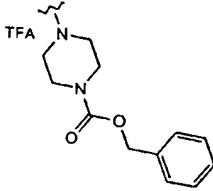
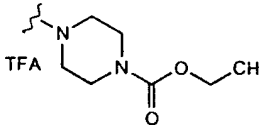
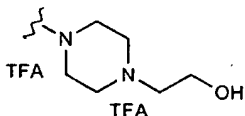
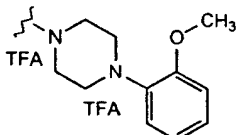
-521-

126-58		3,5-dimethyl- piperidine	414 (M+NH <sub>4</sub> )
126-59		4-(4-bromophenyl)-4- piperidinol	539 (M+H)
126-60		1-methylpiperazine	384 (M+H)
126-61		4-piperazino- acetophenone	488 (M+H)
126-62		1-benzylpiperazine	460 (M+H)
126-63		N-( $\alpha,\alpha,\alpha$ -trifluoro- <i>m</i> - tolyl)piperazine	514 (M+H)
126-64		1-(2-pyridyl)- piperazine	447 (M+H)

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126-65		1-(4-fluorophenyl)- piperazine	464 (M+H)
126-66		1-piperonyl- piperazine	504 (M+H)
126-67		1-(4-nitrophenyl)- piperazine	491 (M+H)
126-68		1-hydroxyethyl- ethoxypiperazine	458 (M+H)
126-69		1-acetylpiperazine	412 (M+H)
126-70		1-ethylpiperazine	398 (M+H)
126-71		1-(2-fluorophenyl)- piperazine	464 (M+H)

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126-72		benzyl-1-piperazine carboxylate	504 (M+H)
126		ethyl-N-piperazine carboxylate	442 (M+H)
127		N-(2-hydroxyethyl)- piperazine	414 (M+H)
128		1-(2-methoxy- phenyl)piperazine	476 (M+H)

## Example XX: Large Scale Preparation of Resin IIIa

Resin II (5 g, 0.91 mmol) was weighed into an oven-dried three-necked round bottom flask fitted with a temperature probe, an overhead stirring paddle, and a nitrogen inlet. Anhydrous 1-methyl-2-pyrrolidinone (35 mL) was added to the flask followed by ethyl isonipecotate (7.0 mL, 45.5 mmol). The resin slurry was stirred slowly with the overhead stirrer, and the mixture was heated to 80 degrees Celsius with a heating mantle for 65 hours. The flask was thereafter cooled to room temperature.

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The resin was collected in a sintered-disk glass funnel and washed with N,N-dimethylformamide, methanol and methylene chloride (3X30 mL each solvent). The resin was dried *in vacuo* to provide  
5 5.86 g of resin IIIa as off-white resin beads. The theoretical loading of the polymer was 0.81 mmol/g. TFA cleavage performed on 50 mg of resin IIIa as described in step 3 yielded 10.4 mg of off-white  
10 solid spectroscopically indistinguishable from the reaction product using ethyl isonipecotate of Example 211.

Example YY: Large Scale Preparation of Resin IIIb:

Preparation of resin IIIb followed the  
15 procedure described for preparation of resin IIIa, except ethyl nipecotate was substituted for ethyl isonipecotate. The yield after drying *in vacuo* was 5.77 g of resin IIIb as pale yellow resin beads. The theoretical loading of the polymer was 0.81 mmol/g.  
20 TFA cleavage performed on 50 mg of resin IIIb as described in step 3 yielded 14.7 mg of off-white solid spectroscopically indistinguishable from the reaction product using ethyl nipecotate of Example 212.

25

Step 4: Hydrolysis of Polymer-Bound  
Ester: Preparation of  
Resin IVa

Resin IIIa (5.8 g, 4.5 mmol) was weighed  
30 into a three-necked round bottomed flask fitted with an overhead stirring paddle. 1,4-Dioxane was added

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to the flask, and the resin slurry was stirred for 15 minutes. Then, a 4 M solution of KOH (5 mL, 20 mmol) was added, and the mixture was stirred for 44 hours. The resin was thereafter collected in a sintered-disk  
5 glass funnel and washed with dioxane/water (9:1), water, 10% acetic acid/water, methanol and methylene chloride (3X30 mL each solvent). The resin was dried *in vacuo* to yield 5.64 g of resin IVa as off-white polymer beads. FTIR microscopy showed bands at 1732  
10 and 1704  $\text{cm}^{-1}$  and a broad band from 2500-3500  $\text{cm}^{-1}$ . The theoretical loading of the polymer-bound acid was 0.84 mmol/g.

Preparation of Resin Ivb:

15 Using the procedure described in Step 4, resin IIIb (5.71 g, 4.5 mmol) was converted into 5.61 g of resin IVb. FTIR microscopy showed bands at 1731 and 1705  $\text{cm}^{-1}$  and a broad band from 2500-3500  $\text{cm}^{-1}$ . The theoretical loading of the polymer-bound acid was  
20 0.84 mmol/g.

Step 5: Amide Bond Formation:

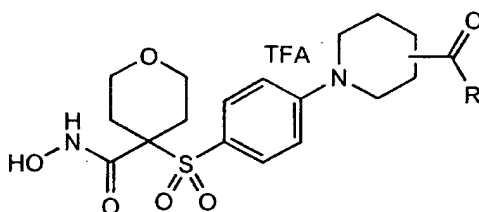
Preparation of Resin V

Into a fritted reaction vessel was weighed  
25 either resin IVa or resin IVb (50 mg, 0.042 mmol), and the vessel was capped under nitrogen. A 0.5 M solution of hydroxybenzotriazole in 1-methyl-2-pyrrolidinone (0.3 mL, 0.15 mmol) was added followed by a 0.5 M solution of diisopropylcarbodiimide in 1-  
30 methyl-2-pyrrolidinone (0.3 mL, 0.15 mmol). The resin was stirred using a tabletop stirring plate for

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15 minutes, then a 0.7 M solution of the amine in 1-methyl-2-pyrrolidinone (0.3 mL, 0.21 mmol) was added. The reaction mixture was stirred for 6 hours, then the resin was drained and washed with 1-methyl-2-pyrrolidinone (3X1mL). The reaction was repeated using the same amounts of reagents described above. The reaction mixture was stirred for 16 hours, then the resin was drained and washed with 1-methyl-2-pyrrolidinone, methanol and methylene chloride (3X1 mL each solvent).

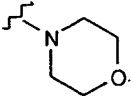
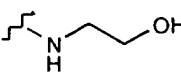
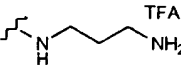
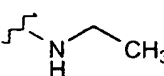
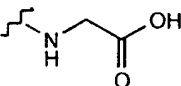
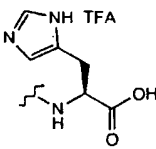
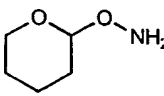
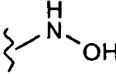

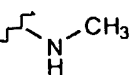
The following hydroxamic acids were synthesized using the indicated polymer-bound acid and the indicated amine in Step 5 reaction conditions followed by release from the polymer using Step 3 reaction conditions.



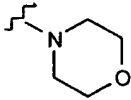
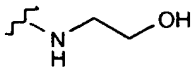
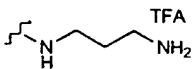
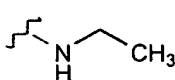
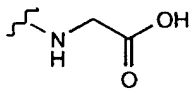
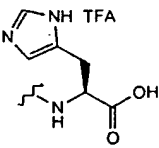
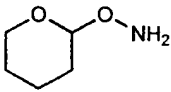
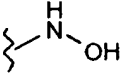
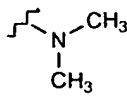
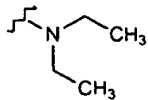
Example Number	Resin	Amine	R	Position	MS (ES)
					m/z
129	IVa	-----	$\text{--OH}$	4	
130	IVa	methylamine	$\text{--NH--CH}_3$	4	



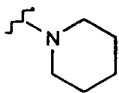
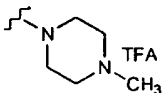
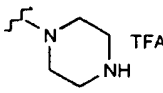
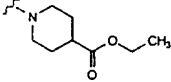
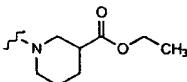
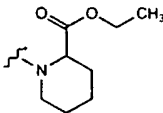
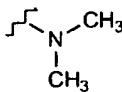
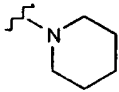
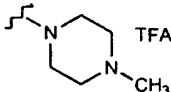
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131	IVa	morpholine		4	482 (M+H)
132	IVa	ethanolamine		4	456 (M+H)
133	IVa	1,3-diamino- propane		4	469 (M+H)
134	IVa	ethylamine		4	440 (M+H)
135	IVa	glycine t- butyl ester HCl		4	470 (M+H)
136	IVa	L-histidine methyl ester HCl		4	564 (M+H)
137	IVa			4	428 (M+H)
138	IVb	-----		3	
139	IVb	methylamine		3	426 (M+H)
140	IVb	morpholine		3	482 (M+H)

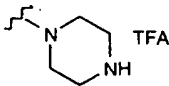
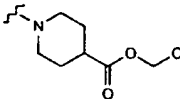
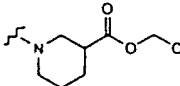
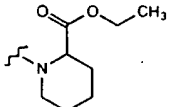
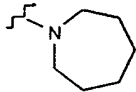
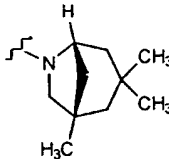
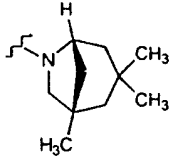
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141	IVb	ethanolamine		3	456 (M+H)
142	IVb	1,3-diamino- propane		3	469 (M+H)
143	IVb	ethylamine		3	440 (M+H)
144	IVb	glycine t- butyl ester HCl		3	470 (M+H)
145	IVb	L-histidine methyl ester HCl		3	564 (M+H)
146	IVb			3	428 (M+H)
147	IVa	dimethylamine		4	440 (M+H)
148	IVa	diethylamine		4	468 (M+H)

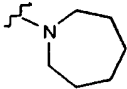
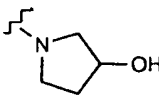
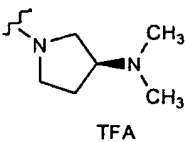
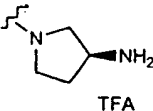
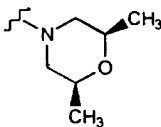
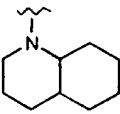
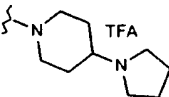

- 529 -

149	IVa	piperidine		4	480 (M+H)
150	IVa	1-methyl- piperazine		4	495 (M+H)
151	IVa	N-Boc- piperazine		4	481 (M+H)
152	IVa	ethyl isonipecotate		4	552 (M+H)
153	IVa	ethyl nipecotate		4	552 (M+H)
154	IVa	ethyl pipecolate		4	552 (M+H)
155	IVb	dimethylamine		3	440 (M+H)
156	IVb	piperidine		3	480 (M+H)
157	IVb	1-methyl- piperazine		3	495 (M+H)
158	IVb	N-Boc-		3	481

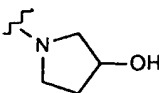
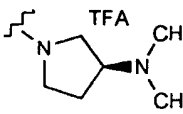
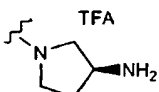
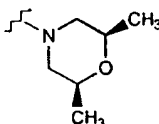
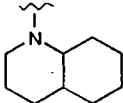
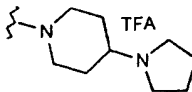
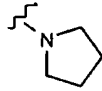
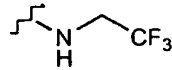
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		piperazine			(M+H)
159	IVb	ethyl isonipecotate		3	552 (M+H)
160	IVb	ethyl nipecotate		3	552 (M+H)
161	IVb	ethyl pipecolate		3	552 (M+H)
162	IVb	hexamethylene- imine		3	494 (M+H)
163	IVb	1,3,3- trimethyl-6- azabicyclo [3.2.1]-octane		3	548 (M+H)
164	IVa	1,3,3- trimethyl-6- azabicyclo [3.2.1]-octane		4	548 (M+H)

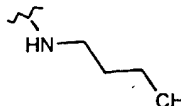
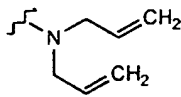
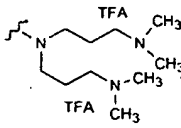
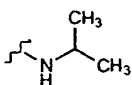
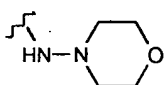
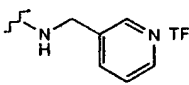
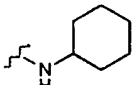
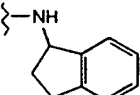
- 531 -

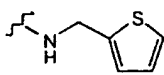
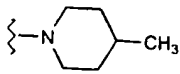
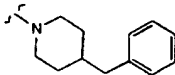
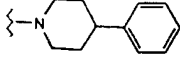
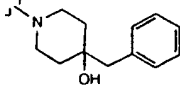
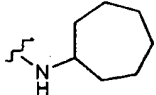
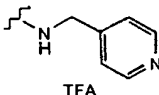
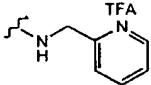
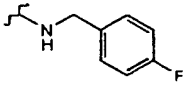
165	IVa	hexamethylene- imine		4	494 (M+H)
166	IVb	3-pyrrolidinol		3	482 (M+H)
167	IVb	(3S) - (-) - 3- (dimethyl amino) - pyrrolidine		3	509 (M+H)
168	IVb	(3S) - (-) - 3- (t-butoxy- carbonylamino) -pyrrolidine		3	481 (M+H)
169	IVb	cis-2,6- dimethyl- morpholine		3	510 (M+H)
170	IVb	decahydro- quinoline		3	534 (M+H)
171	IVb	4-(1- pyrrolidinyl) - piperidine		3	549 (M+H)
172	IVb	pyrrolidine		3	466 (M+H)

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173	IVa	3-pyrrolidinol		4	482 (M+H)
174	IVa	(3S) - (-) - 3- (dimethyl amino) - pyrrolidine		4	509 (M+H)
175	IVa	(3S) - (-) - 3- (t-butoxy- carbonylamino) -pyrrolidine		4	481 (M+H)
176	IVa	cis-2,6- dimethyl- morpholine		4	510 (M+H)
177	IVa	decahydro- quinoline		4	534 (M+H)
178	IVa	4-(1- pyrrolidinyl) - piperidine		4	549 (M+H)
179	IVa	pyrrolidine		4	466 (M+H)
180	IVa	2,2,2-tri- fluoroethyl- amine		4	494 (M+H)

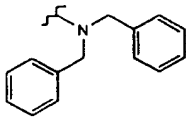
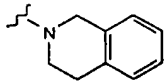
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181	IVa	butylamine		4	468 (M+H)
182	IVa	diallylamine		4	492 (M+H)
183	IVa	3,3'- iminobis (N,N- dimethylpropyl- amine)		4	582 (M+H)
184	IVa	iso- propylamine		4	454 (M+H)
185	IVa	4-amino- morpholine		4	497 (M+H)
186	IVa	3- (aminomethyl)- pyridine		4	503 (M+H)
187	IVa	cyclohexyl- amine		4	494 (M+H)
188	IVa	1-aminoindane		4	528 (M+H)

189	IVa	2-thiophene- methylamine		4	508 (M+H)
190	IVa	4-methyl- piperidine		4	494 (M+H)
191	IVa	4-benzyl- piperidine		4	570 (M+H)
192	IVa	4-phenyl- piperidine		4	556 (M+H)
193	IVa	4-benzyl-4- hydroxy- piperidine		4	586 (M+H)
194	IVa	cycloheptyl- amine		4	508 (M+H)
195	IVa	4-aminomethyl- pyridine		4	503 (M+H)
196	IVa	2-amino- methyl- pyridine		4	503 (M+H)
197	IVa	4-fluoro- benzylamine		4	520 (M+H)



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198	IVa	dibenzylamine		4	592 (M+H)
199	IVa	1,2,3,4-tetrahydro- isoquinoline		4	528 (M+H)

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#### Large Scale Preparation of Resin IIIC

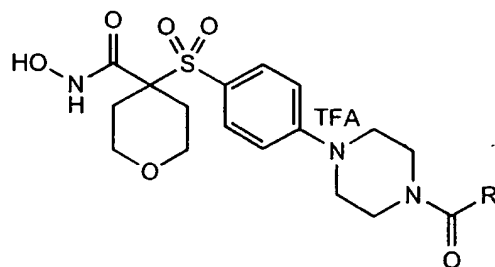
Resin II (3.01 g, 2.74 mmol) was weighed  
5 into an oven-dried three-necked round bottomed flask  
fitted with an overhead stirring paddle, a  
temperature probe and an nitrogen inlet. 1-Methyl-2-  
pyrrolidinone (25 mL) was added followed by  
piperazine (2.36 g, 27.4 mmol) and cesium carbonate  
10 (8.93 g, 27.4 mmol). Additional 1-methyl-2-  
pyrrolidinone (10 mL) was added, and the reaction  
mixture was heated to 100 degrees Celsius and stirred  
18 hours. The flask was cooled to room temperature,  
and the resin was collected in a sintered-disc funnel  
15 and washed with N,N-diethylformamide/water (1:1),  
water, 10% acetic acid/water, methanol, and methylene  
chloride (3X30 mL each solvent). The yield after  
drying in vacuo was 3.14 g of resin IIIb as pale  
yellow resin beads. The theoretical loading of the  
20 polymer was 0.86 mmol/g. TFA cleavage performed on  
50 mg of resin IIIb as described in Step 3 yielded 21  
mg of off-white solid spectroscopically  
indistinguishable from the compound of Example 209.

Step 6: Amide Bond Formation with  
resin IIIc: Preparation of  
Resin VI

5           Into a fritted reaction vessel was placed  
the carboxylic acid (0.215 mmol) and 1-  
hydroxybenzotriazole (44 mg, 0.326 mmol). The vessel  
was capped under nitrogen, and 1-methyl-2-  
pyrrolidinone was added followed by  
10 diisopropylcarbodiimide (0.034 mL, 0.215 mmol). The  
solution was agitated on a tabletop shaker for 15  
minutes, then resin IIIc (50 mg, 0.043 mmol) was  
added in one portion. The reaction mixture was  
shaken for 16 hours, then the resin was drained and  
15 washed with 1-methyl-2-pyrrolidinone, methanol and  
methylene chloride (3X1 mL each solvent). In the  
case of N-9-fluorenyl-methoxycarbonyl-protected amino  
acids, the resin was further treated with a  
piperidine/N,N-dimethylformamide solution (1:4, 1 mL)  
20 for 30 minutes. The resin was drained and washed with  
N,N-dimethylformamide, methanol and methylene  
chloride (3X1 mL each solvent).

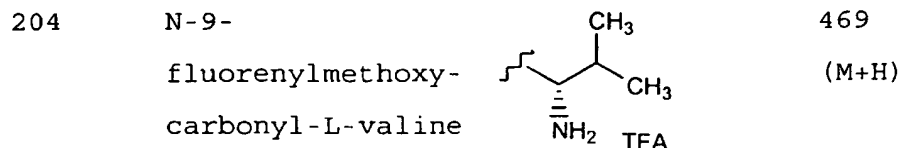
          The following hydroxamic acids were  
25 synthesized from resin IIIc using Step 6 with the  
indicated carboxylic acid, followed by release from  
the polymer using Step 3 reaction conditions.

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Example Number	Carboxylic Acid	R	MS (ES) m/z
200	cyclo-hexanecarboxylic acid		502 (M+Na)
201	1,2,3,4-tetrahydronaphthylene-2-carboxylic acid		545 (M+NH <sub>4</sub> )
202	cycloheptane-carboxylic acid		511 (M+NH <sub>4</sub> )
203	N-9-fluorenylmethoxy-carbonyl-L-proline	 TFA	467 (M+H)

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Step 7: Preparation of Resin VII

5                Resin IIIc (1.0g, 0.86 mmol) was weighed into an oven-dried 100 mL round-bottomed flask and a magnetic stirring bar and septum with a nitrogen needle were added. Methylene chloride (10 mL) was added, and the resin slurry was slowly stirred. p-  
10 Nitrophenylchloro-formate (0.867 g, 4.3 mmol) was added in one portion, followed by dropwise addition of diisopropylethylamine (0.75 mL, 4.3 mmol). A slight warming was noted with the addition. The reaction was stirred at room temperature for 18  
15 hours, then the resin was collected in a sintered-disc glass funnel and washed with methylene chloride, methanol and methylene chloride (3X10 mL each solvent).

                 The polymer-bound product was dried in  
20 vacuo yielding 1.25 g of resin VII as brown resin beads. FTIR microscopy showed bands at 1798, 1733, 1696 and 1210  $\text{cm}^{-1}$ . Theoretical loading of the polymer was 0.75 mmol/g.

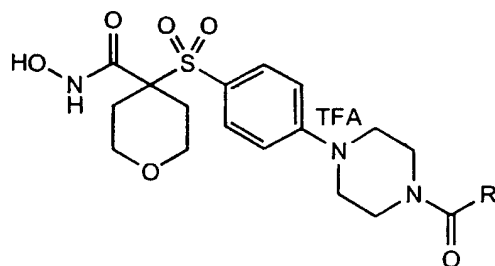
-539-

Step 8: Reaction of Resin VII with  
Amines Preparation of  
Resin VIII

An 8 mL vial was charged with resin VII (50  
5 mg, 0.038 mmol) and a small magnetic stirring bar,  
and a 0.5 M solution of the amine in 1-methyl-2-  
pyrrolidinone (1 mL) was added. The vial was capped  
and heated to 50 degrees Celsius. The resin slurry  
was gently stirred for 15 hours, then the vial was  
10 cooled to room temperature. The resin was collected  
in a fritted reaction vessel and washed with 1-  
methyl-2-pyrrolidinone, methanol and methylene  
chloride (3X10 mL each solvent).

The following hydroxamic acids were  
15 synthesized from resin VII using Step 8 reaction  
conditions with the indicated amine, followed by  
release from the polymer using Step 3 reaction  
conditions.

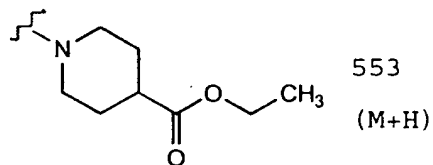
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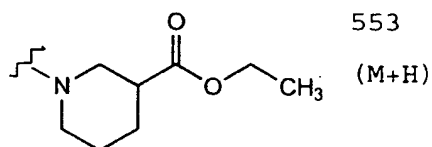
Example Number	Carboxylic Acid	R	MS (ES) m/z
205	-----		535 (M+H)
206	piperidine		481 (M+H)
207	morpholine		501 (M+Na)
208	dimethylamine		441 (M+H)
209	piperazine		482 (M+H)
210	1-methyl-piperazine		496 (M+H)

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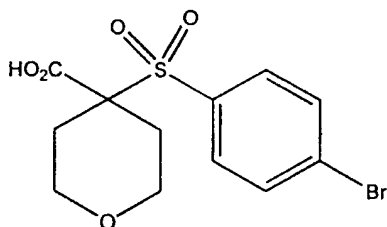
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isonipecotate



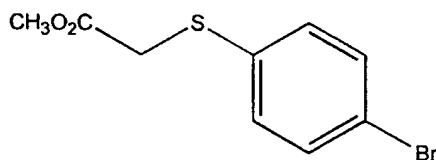
212 ethyl  
nipecotate



Example xxx: Preparation of 4-[(4-bromophenyl)-  
sulfonyl]tetrahydro-2H-  
pyran-4-carboxylic acid



Part A: Preparation of



A 60% sodium hydride oil dispersion (4.0 g,  
0.1 mole) was weighed into an oven-dried 3-necked 500  
mL round-bottomed flask in a nitrogen glove bag, and

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the flask was fitted with an nitrogen inlet, a temperature probe, an overhead stirring paddle and rubber septa. Anhydrous tetrahydrofuran (200 mL) was added to the flask, which was then cooled in an ice bath. 4-Bromothiophenol (18.91 g, 0.1 mole) was added dropwise, maintaining a temperature less than 7 degrees Celsius. Vigorous gas evolution was noted throughout addition. After complete addition, the mixture was stirred for 10 minutes with cooling.

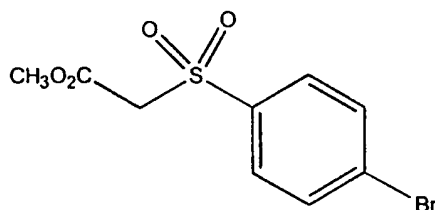
Then, methyl bromoacetate (9.5 mL, 0.1 mole) was added dropwise, maintaining a temperature less than 7 degrees Celsius. The reaction was stirred for 10 minutes with cooling, then the ice bath was removed and the mixture stirred an additional 30 minutes.

The reaction was quenched by the addition of 5 mL water, then solvent was removed on rotary evaporator. The residual oil was partitioned between ethyl acetate (200 mL) and water (200 mL). The organic layer was washed with 5% hydrogen choride/water (1x200 mL), saturated sodium bicarbonate (1x200 mL) and brine (1x200 mL). The organic phase was dried over magnesium sulfate and concentrated to give 24.53 g of the product as a yellow oil (94%). <sup>1</sup>H NMR was consistent with the desired structure. The mass spectrum showed an *m/z* 260 (M+H).



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## Part B: Preparation of

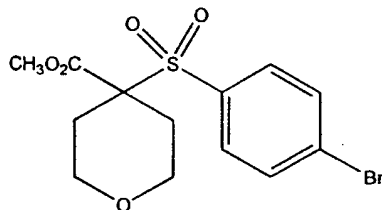


5           The compound of part A, above, (24.5 g, 0.094 mole) was weighed into a 1.0 L round-bottomed flask fitted with an overhead stirring paddle and temperature probe, then 550 mL of methanol were added, followed by 55 mL of water, causing the  
10 solution to become slightly turbid. The flask was immersed in an ice bath, and once the temperature fell below 5 degrees Celsius, Oxone® (144.5 g, 0.235 mole) was added portionwise over 5 minutes. A slight increase in temperature to 8 degrees Celsius was  
15 noted. The reaction was stirred with cooling for 10 minutes, then the ice bath was removed. After 4 hours, reversed-phase high pressure liquid chromatography showed a single component at 13.6 minutes. The reaction mixture was filtered, and the  
20 solid washed exhaustively with methanol. The combined filtrates were concentrated on a rotary evaporator, and the residual material partitioned between ethyl acetate (300 mL) and water (200 mL). The organic layer was washed with water (3x200 mL),  
25 saturated sodium bicarbonate (1x200 mL) and brine (1x200 mL), then the organic phase was dried over magnesium sulfate and concentrated to give 25 g of

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the product as a tan solid. Trituration with hexane provided 24.3 g of pure sulfone as an off-white solid (88%).  $^1\text{H}$  NMR was consistent with the desired structure. The mass spectrum showed an  $m/z$  293 (M+H).

10 Part C: Preparation of



A 60% sodium hydride oil dispersion (5.76 g, 0.144 mole) was weighed into an oven-dried 3-necked 1.0 L round-bottomed flask in a nitrogen glove bag, and then the flask was fitted with a nitrogen inlet, a temperature probe, an overhead stirring paddle and rubber septa. Anhydrous N,N-dimethylformamide (250 mL) was added to the flask, mechanical stirring was initiated, and the mixture heated to 50 degrees Celsius. A solution of the compound of part B, above, (17.59 g, 0.06 mole) and dibromodiethyl ether (14.5 g, 0.06 mole) in 40 mL of N,N-dimethylformamide was added dropwise to the sodium hydride slurry, maintaining a temperature between 50-55 degrees Celsius and a steady evolution of hydrogen. After complete addition, the

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temperature of the reaction mixture was increased to 65 degrees Celsius, and the mixture was stirred for 2 hours. The flask was then cooled to room temperature, and the flask was immersed in an ice bath. When the temperature fell below 20 degrees Celsius, 0.5 L ice water was added.

The mixture was transferred to a 4.0 L separatory funnel, an additional 1.0 L of water was added, and the mixture was extracted with ethyl acetate (3x200 mL). The combined organic layers were washed with 5% hydrogen chloride/water (1x200 mL), saturated sodium carbonate (1x200 mL), and brine (1x200 mL), dried over magnesium sulfate, and concentrated in vacuo to give 18.2 g of crude product as a yellow semi-solid. Recrystallization from ethyl acetate/hexane gave 6.53 g of pure product as tan crystals (30%). <sup>1</sup>H NMR was consistent with the desired structure. The mass spectrum showed an m/z 363 (M+H).

Part D: Preparation of the title compound  
A solution of the compound of part C, above, (4.57 g, 12.6 mmol) in 50 mL of dry

tetrahydrofuran in an oven-dried 100 mL round-bottomed flask was stirred at room temperature under nitrogen, and 4.84 g of potassium trimethylsilanolate (37.7 mmol) were added in one portion. The mixture was stirred for two hours, then 10 mL of water were added dropwise. The volatiles were removed in vacuo, and the residue partitioned between 100 mL ethyl ether and 100 mL water. The aqueous layer was acidified to a pH value of less than 2 using

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concentrated hydrogen chloride, causing a white precipitate. This mixture was extracted with ethyl acetate (3x75 mL), and the combined ethyl acetate layers were dried over magnesium sulfate and concentrated in vacuo to give 4.15 g of pure product as a white solid (94%).  $^1\text{H}$  NMR ( $\text{CDCl}_3/\text{CD}_3\text{OD}$ ) 2.10 (m, 4H), 3.28 (m, 2H), 3.90 (m, 2H), 7.60 (m, 4 H). The mass spectrum showed an  $m/z$  349 (M+H).

10 Step 9: Attachment to Resin I:

Preparation of Resin IX

Following the procedure outlined in Step 1 before, 3.13 g of the title compound of the above preparation was reacted with 3.73 g of resin I to give 5.19 g of polymer-bound hydroxamate as a tan polymeric solid. Theoretical loading on polymer was 0.86 mmol/g. FTIR microscopy showed bands at 1693 and 3332  $\text{cm}^{-1}$  indicative of the hydroxamate carbonyl and nitrogen-hydrogen stretches, respectively.

20

Step 10: Palladium Catalyzed Reaction  
of Resin IX with Boronic  
Acids: Preparation of  
Resin VII

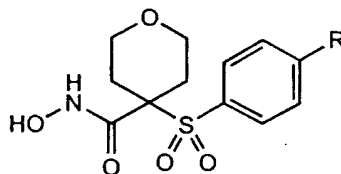
25 Into an 8 mL glass solid phase reaction vessel was weighed resin IX (50 mg, 0.043 mmol). The resin was washed with dry dimethoxyethane (2x3 mL). A 0.017 M solution of the palladium tetrakis(triphenyl phosphine) (0.6 mL, 0.01 mmol) was added to the vessel followed by a 0.6 M solution of the boronic acid in 1:1 dimethoxyethane /ethanol (0.6 mL, 0.36 mmol) and

30

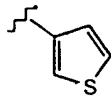
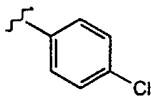
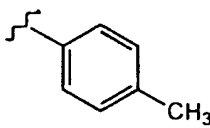
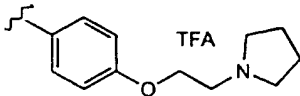
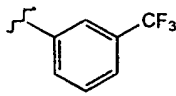
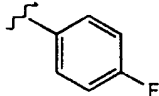
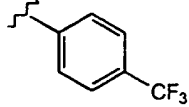
-547-

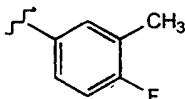
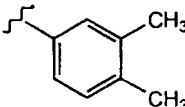
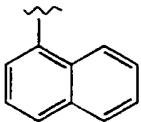
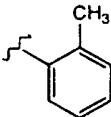
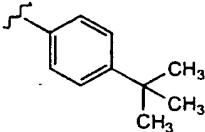
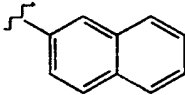
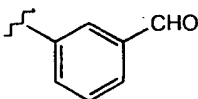
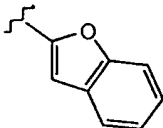
a 2M solution of potassium hydroxide in water (0.4 mL, 0.8 mmol). The vessel was maintained under a positive pressure of argon and heated at 90 degrees Celsius 16 hours. The vessel was cooled to room temperature, then the resin was drained and washed with 1-methyl-2-pyrrolidinone, 1-methyl-2-pyrrolidinone/water (1:1), water, acetic acid/water (1:9), methanol, and methylene chloride (3x3 mL each solvent).

The following hydroxamic acids were synthesized from resin IX using Step 10 reaction conditions with the indicated boronic acid, followed by cleavage from the polymer using Step 3 reaction conditions.

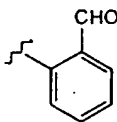
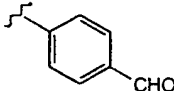
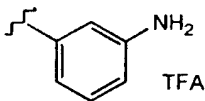


Example Number	Boronic Acid	R	MS
			(ES) m/z
213	phenylboronic acid		362 (M+H)
214	3-nitrophenyl-boronic acid		424 (M+NH <sub>4</sub> )

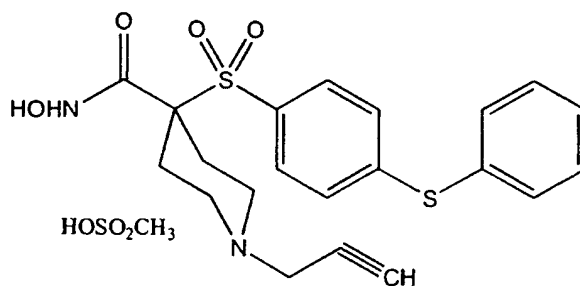
215	thiophene-3- boronic acid		368 (M+H)
216	4-chlorobenzene boronic acid		413 (M+NH <sub>4</sub> )
217	4-methyl- benzeneboronic acid		414 (M+K)
218	4-(2- pyrrolidinyl- ethoxy) - benzeneboronic acid		476 (M+NH <sub>4</sub> )
219	3-(tri- fluoromethyl) - benzeneboronic acid		430 (M+H)
220	4-fluoro- benzeneboronic acid		418 (M+K)
221	4-(tri- fluoromethyl) - benzeneboronic acid		447 (M+NH <sub>4</sub> )

222	4-fluoro-3-methylbenzeneboronic acid		411 (M+NH <sub>4</sub> )
223	3,4-dimethylbenzeneboronic acid		407 (M+NH <sub>4</sub> )
224	1-naphthyleneboronic acid		412 (M+H)
225	2-methylbenzeneboronic acid		376 (M+H)
226	4-t-butylbenzeneboronic acid		418 (M+H)
227	2-naphthyleneboronic acid		412 (M+H)
228	3-formylbenzeneboronic acid		390 (M+H)
229	benzofuran-2-boronic acid		419 (M+NH <sub>4</sub> )

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230	2-formyl- benzeneboronic acid		390 (M+H)
231	4-formyl- benzeneboronic acid		390 (M+H)
232	3-amino- benzeneboronic acid		377 (M+H)

Example 233: Preparation of Monomethanesulfonate  
salts: N-hydroxy-4-[[4-(phenylthio)  
5 phenyl]-sulfonyl]-1-(2-propynyl)-4-  
piperidine-carboxamide,  
monomethanesulfonate



#### First Preparation

Part A: A solution of the compound of  
Example 9, Part J (2.1 g, 4.5 mmol) in warm H<sub>2</sub>O (200  
mL) was admixed with NaHCO<sub>3</sub> at ambient temperature.  
15 After stirring for 20 minutes, the resulting white



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solid was isolated by filtration, washed with water and dried at 37 degree Celsius in a vacuum oven to afford the free base of the title compound as a white solid (1.7 g, 86%); Anal. calcd for  $C_{21}H_{22}N_2O_4S_2 \cdot 0.3H_2O$ :  
5 C, 57.86; H, 5.23; N, 6.43; S, 14.71. Found: C, 57.84; H, 4.96; N, 6.39; S, 14.89.

Part B: Methanesulfonic acid (0.28 mL, 4.1 mmol) was added to a solution of the free base of part A (1.6 g, 3.7 mmol) in methanol (10 mL) at  
10 ambient temperature. After 3 hours, the resulting solid was isolated by filtration, washed with methanol, and dried at ambient temperature in a vacuum oven to afford the monomethanesulfonate titled compound as a white solid (1.6 g, 81%): Anal. calcd  
15 for  $C_{21}H_{22}N_2O_4S_2 \cdot CH_4O_3$ : C, 48.51; H, 5.18; N, 5.14; S, 17.66. Found: C, 48.88; H, 5.15; N, 5.23; S, 17.81.

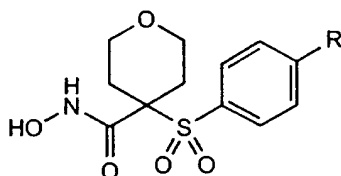
#### Second Preparation

Methanesulfonic acid (0.91 mL, 14 mmol) was  
20 added to a solution of the protected hydroxamate of Example 9, Part I (6.0 g, 12 mmol) in methanol (37 mL) under a nitrogen atmosphere. After 1 hour, the precipitate was isolated by filtration, washed with methanol, and dried at 40 degrees Celsius in a vacuum  
25 oven for 1 day to afford the monomethanesulfonate title compound as a white solid (5.5 g, 89%) identical to the material from Example 233, First Preparation.

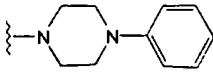
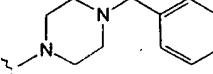
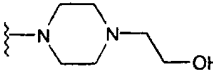
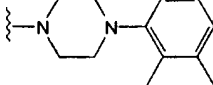
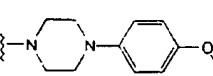
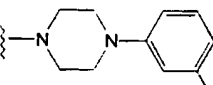
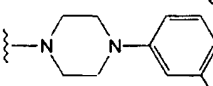
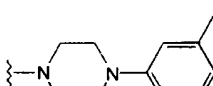
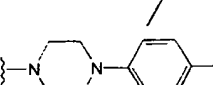
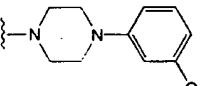
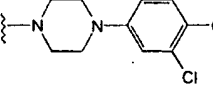
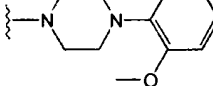
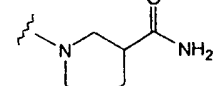
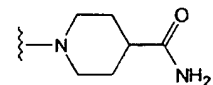
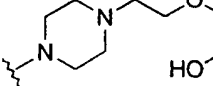
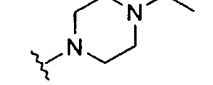
Methanesulfonate salts of the other cyclic  
30 amine compounds disclosed herein can be similarly prepared using the methods of the above two preparations.

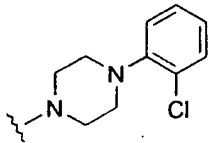
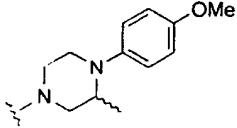
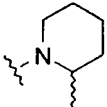
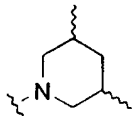
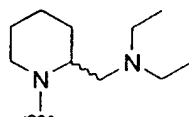
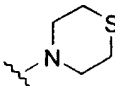
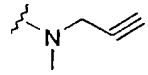
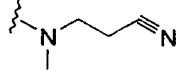
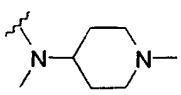
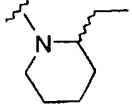
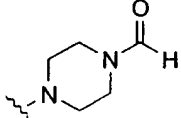
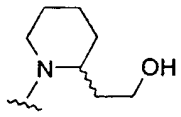
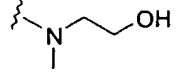
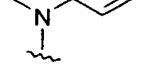
## Example 234-280:

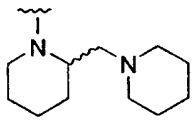
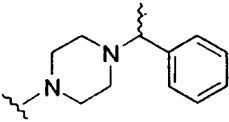
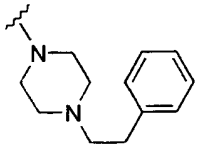
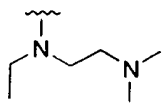
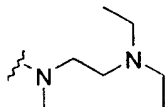
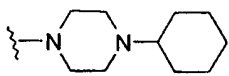
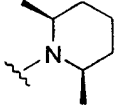
The compounds of Example 234-280 were prepared as described for the compounds of Example 5 129-199.



Example Number	Resin	Amine	R	Position	MS (ES) m/z
234	IVb	N-methyl homopiperazine		4	509 (M+H)
235	IVb	6,7-dimethoxy-1,2,3,4-tetrahydroisoquinoline HCl		4	588 (M+H)
236	IVb	tetrahydro-pyridine		4	478 (M+H)
237	IVb	R-3-hydroxy-piperidine HCl		4	496 (M+H)
238	IVb	phenyl-piperazine		4	557 (M+H)
239	IVb	benzyl-piperazine		4	571 (M+H)
240	IVa	methyl homopiperazine		3	509 (M+H)
241	IVa	6,7-dimethoxy-1,2,3,4-tetrahydroisoquinoline HCl		3	588 (M+H)
242	IVa	tetrahydro-pyridine		3	478 (M+H)
243	IVa	R-3-hydroxy-piperidine HCl		3	496 (M+H)

244	IVa	phenyl- piperazine		3	557 (M+H)
245	IVa	benzyl- piperazine		3	571 (M+H)
246	IVb	hydroxyethyl- piperazine		4	525 (M+H)
247	IVb	1-(2,3-xylyl)- piperazine HCl		4	585 (M+H)
247	IVb	1-(4-methoxy- phenyl)- piperazine 2HCl		4	587 (M+H)
249	IVb	1-(3- chlorophenyl)- piperazine HCl		4	591 (M+H)
250	IVb	1-(m-tolyl)- piperazine 2HCl		4	571 (M+H)
251	IVb	1-(2,5-dimethyl- phenyl)piperazine		4	585 (M+H)
252	IVb	1-(p-toyl)- piperazine 2HCl		4	571 (M+H)
253	IVb	1-(3-methoxy- phenyl)- piperazine 2HCl		4	587 (M+H)
254	IVb	1-(3,4-dichloro- phenyl)piperazine		4	625 (M+H)
255	IVb	1-(2-methoxy)- piperazine HCl		4	587 (M+H)
256	IVb	nipecotamide		4	523 (M+H)
257	IVb	isonipecotamide		4	523 (M+H)
258	IVb	1-(2-(2-hydroxy- ethoxyethyl)- piperazine		4	569 (M+H)
259	IVb	1-ethyl- piperazine		4	509 (M+H)

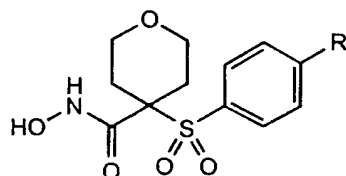
260	IVb	1-(2-chlorophenyl)-piperazine HCl		4	591 (M+H)
261	IVb	1-(4-methoxyphenyl)-2-methyl-piperazine		4	601 (M+H)
262	IVb	2-methyl-piperidine		4	494 (M+H)
263	IVb	3,5-dimethyl-piperidine		4	508 (M+H)
264	IVb	N-(2-piperidyl-methyl)-diethylamine		4	565 (M+H)
265	IVb	thiomorpholine HCl		4	498 (M+H)
266	IVb	N-methyl-propargylamine		4	464 (M+H)
267	IVb	N-methyl-β-alaninenitrile		4	479 (M+H)
268	IVb	1-methyl-4-(methyl-amino)piperidine		4	523 (M+H)
269	IVb	2-ethyl-piperidine		4	508 (M+H)
270	IVb	1-piperazine-carboxaldehyde		4	509 (M+H)
271	IVb	2-piperidin-ethanol		4	524 (M+H)
272	IVb	2-(methylamino)-ethanol		4	470 (M+H)
273	IVb	N-methylallyl-amine		4	466 (M+H)

274	IVb	2-(piperidino- methyl)- piperidine		4	577 (M+H)
275	IVb	1-(1-phenyl- ethyl)- piperazine		4	585 (M+H)
276	IVb	1-(2-phenyl- ethyl)- piperazine		4	585 (M+H)
277	IVb	N,N-dimethyl- N'-ethylene- diamine		4	511 (M+H)
278	IVb	N,N-diethyl-N- methylene- ethylenediamine		4	525 (M+H)
279	IVb	1-cyclohexyl- piperazine		4	563 (M+H)
280	IVb	2,6-dimethyl- piperidine		4	508 (M+H)

Example 281-288:

The following hydroxamic acids were  
 5 synthesized from Resin IX using Step 10 with the  
 indicated boronic acid, followed by cleavage from the  
 polymer using Step 3, as discussed previously for  
 Example 213-232:

-556-



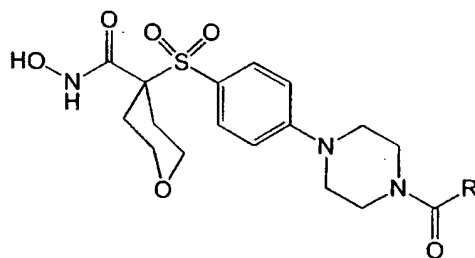
Example Number	Boronic acid	R	MS (ES) m/z
281	4-methoxy-benzeneboronic acid		392 (M+H)
282	3-methoxy-benzeneboronic acid		392 (M+H)
283	4-methylthio-benzeneboronic acid		408 (M+H)
284	4-MeNHSO <sub>2</sub> -benzene boronic acid		455 (M+H)
285	4-carboxybenzene-boronic acid		406 (M+H)
286	2-trifluoromethyl-benzeneboronic acid		430 (M+H)
287	3,5-bis-(trifluoromethyl)-benzeneboronic acid		498 (M+H)
288	2,3,4-trifluoro-benzeneboronic acid		416 (M+H)

Example 289-294:

Step 11: Preparation of Resin XI.

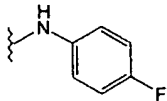
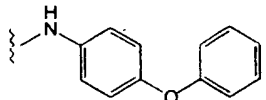
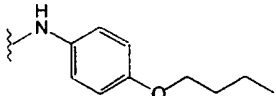
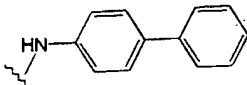
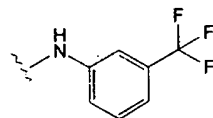
Into a fritted reaction vessel was placed Resin IIIc (50 mg, 0.043 mmol). A 0.43 M solution of the isocyanate in 1-methyl-2-pyrrolidinone (1 mL, 0.43 mmol) was added followed by diisopropylethylamine (75 uL, 0.43 mmol). The vessel was capped under nitrogen, agitated on a tabletop shaker, and heated to 50 degrees Celsius for 48 hours. Then, the vessel was cooled to room temperature, and the resin was drained and washed with 1-methyl-2-pyrrolidinone, 1:1 1-methyl-2-pyrrolidinone/water, water, 1:9 acetic acid/water, methanol and methylene chloride (3X1 mL each solvent).

The following hydroxamic acids were synthesized from Resin IIIc using Step 11 with the indicated isocyanate, followed by release from the polymer using the reaction conditions in Step 3.



Example Number	Isocyanate	R	MS (FAB) m/z
289	phenyl isocyanate		489.1 (M+H)

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290	4-fluorophenyl isocyanate		507.2 (M+H)
291	4-phenoxyphenyl isocyanate		581.3 (M+H)
292	4-butoxyphenyl isocyanate		561.4 (M+H)
293	4-phenylphenyl- isocyanate		565.2 (M+H)
294	$\alpha,\alpha,\alpha$ -trifluoro m-tolyl ioscyanate		557.2 (M+H)

Example 295-300:

Step 12: Synthesis of Resin XII.

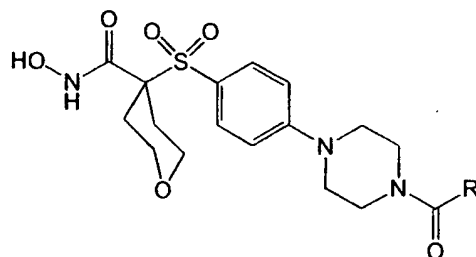
- 5 Into a fritted reaction vessel was placed resin VII (50 mg, 0.038 mmol) and cesium carbonate (122 mg, 0.38 mmol). A 0.43 M solution of the phenol in 1-methyl-2-pyrrolidinone (1 mL, 0.43 mmol) was added, then the vessel was capped under nitrogen.
- 10 The reaction mixture was agitated on a tabletop shaker and heated to 50 degrees Celsius for 48 hours. Then, the vessel was cooled to room temperature, and the resin was drained and washed with 1-methyl-2-pyrrolidinone, 1:1 1-methyl-2-pyrrolidinone/water,
- 15 water, 1:9 acetic acid/water, methanol and methylene chloride (3X1 mL each solvent).

The following hydroxamic acids were synthesized from Resin IIIc using Step 11 with the

20 indicated isocyanate, followed by release from the polymer using the reaction conditions in Step 3.



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Example Number	Phenol	R	MS (FAB) m/z
295	phenol		490 (M+H)
296	3-methoxyphenol		520 (M+H)
297	4-chlorophenol		524.1 (M+H)
298	p-cresol		504.3 (M+H)
299	4-phenylphenol		566.3 (M+H)
300	4-hydroxy-diphenyl-methane		580.2 (M+H)

5

Example 301-323:Large Scale Preparation of Resin Xa

10

A fritted reaction vessel was charged with Resin IX (1 g, 0.86 mmol) and a 0.008 M solution of tetrakis-(triphenylphosphine)palladium(0) in ethylene glycol dimethyl ether (5 mL, 0.04 mmol). A 1 M solution of 2-formylbenzenboronic acid in a 1:1

-560-

mixture of ethanol and ethylene glycol dimethyl ether (6 mL, 6 mmol) was added followed by 1 M cesium carbonate in water (2 mL, 2 mmol). The vessel was sealed under argon and heated to 90 degrees Celsius for 16 hours. After this, the vessel was cooled to room temperature, and the resin drained and washed with the following sequence of solvents dimethylformamide, 1:1 dimethylformamide/water, dimethylformamide, water, methanol, methylene chloride (3X5 mL each solvent). The resin was dried in vacuo to yield 1.025 g of product as a tan polymeric solid. The theoretical loading of the polymer was 0.84 mmol/g. TFA cleavage performed on 35 mg of Resin Xa as described in Step 3 yielded 11.2 mg of a tan solid

#### Large Scale Preparation of Resin Xb.

Preparation of Resin Xb followed the identical procedure described for preparation of resin Xa, except 3-formylbenzeneboronic acid was substituted for 2-formylbenzeneboronic acid. The yield after drying in vacuo was 1.052 g of Resin Xb as tan resin beads. The theoretical loading of the polymer was 0.84 mmol/g. TFA cleavage performed on 20 mg of Resin Xb as described in Step 3 yielded 6.5 mg of a tan solid.

#### Large Scale Preparation of Resin Xc.

Preparation of Resin Xc followed the identical procedure described for preparation of resin Xa, except 4-formylbenzeneboronic acid was substituted for 2-formylbenzeneboronic acid. The yield after drying in vacuo was 1.03 g of Resin Xc as tan resin

-561-

beads. The theoretical loading of the polymer was 0.84 mmol/g. TFA cleavage performed on 28 mg of Resin Xb as described in Step 3 yielded 9.4 mg of a tan solid.

5

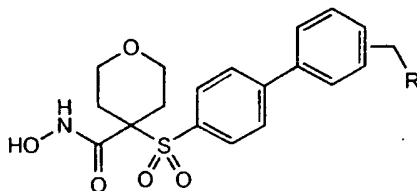
Step 13: Synthesis of Resin XIII.

Into a fritted reaction vessel was placed resin Xa, Xb or Xc (50 mg, 0.042 mmol). A 0.2 M solution of the amine in trimethylorthoformate (1 mL, 10 0.2 mmol) was added, and the vessel was capped under nitrogen. The reaction mixture was agitated on a tabletop shaker for 3 hours. Then, a 0.5 M solution of sodium triacetoxyborohydride in 1-methyl-2-pyrrolidinone (0.8 mL, 0.4 mmol) was added to the 15 vessel, and the mixture was agitated an additional 40 hours. After this, the resin was drained and washed (3X1 mL each solvent) with the following sequence of solvents: 1-methyl-2-pyrrolidinone, methanol, water, methanol and methylene chloride.

20

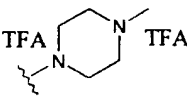
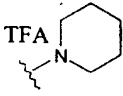
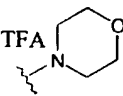
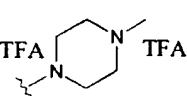
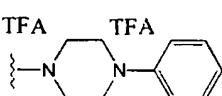
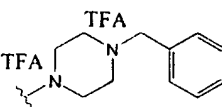
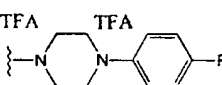
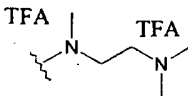
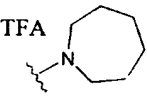
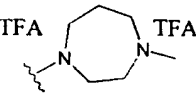
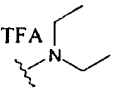
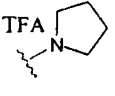

The following hydroxamic acids were synthesized using the indicated resin-bound aldehyde and the indicated amine following the procedure outlined in Step 13 followed by release from the polymer using 25 the procedure in Step 3:

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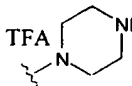


Example Number	Resin	Amine	R	position	MS (ES) m/z
301	Xb	1,2,3,4-tetrahydro-isoquinoline		3	507 (M+H)
302	Xb	1-methyl-piperazine		3	474 (M+H)
303	Xb	piperazine		3	460 (M+H)
304	Xb	benzylamine		3	481 (M+H)
305	Xb	propylamine		3	433 (M+H)
306	Xb	ethyl isonipecotate		3	531 (M+H)
307	Xa	benzylamine		2	481 (M+H)
308	Xa	isopropylamine		2	433 (M+H)
309	Xa	1,2,3,4-tetrahydro-isoquinoline		2	507 (M+H)

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310	Xa	1-methyl-piperazine		2	474 (M+H)
311	Xc	piperidine		4	459 (M+H)
312	Xc	morpholine		4	461 (M+H)
313	Xc	1-methyl-piperazine		4	474 (M+H)
314	Xc	1-phenyl-piperazine		4	536 (M+H)
315	Xc	1-benzyl-piperazine		4	550 (M+H)
316	Xc	1-(4-fluoro-phenyl)-piperazine		4	554 (M+H)
317	Xc	N,N,N'-trimethyl-ethylenediamine		4	476 (M+H)
318	Xc	hexamethyl-eneimine		4	473 (M+H)
319	Xc	1-methyl-homopiperazine		4	488 (M+H)
320	Xc	diethylamine		4	447 (M+H)
321	Xc	pyrrolidine		4	445 (M+H)
322	Xb	dimethylamine		3	419 (M+H)

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323	Xc	1-t-butoxy- carbonyl- piperazine		4	460 (M+H)
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#### Large Scale Preparation of Resin Xd

Preparation of Resin Xd followed the identical procedure described for preparation of resin Xa, except 4-carboxybenzeneboronic acid was substituted for 2-formylbenzeneboronic acid. The yield after drying in vacuo was 1.07 g of Resin Xd as a tan polymeric solid. The theoretical loading of the polymer was 0.83 mmol/g. TFA cleavage performed on 23.5 mg of Resin Xd as described in Step 3 yielded 4.9 mg of a tan solid.

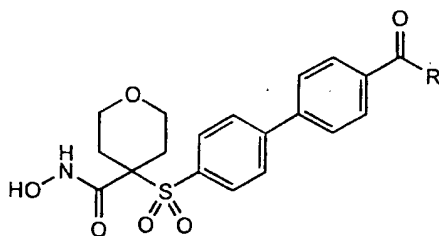
#### Step 14: Synthesis of Resin XIV

Into a fritted reaction vessel was placed resin Xd (50 mg, 0.042 mmol). The resin was washed with 1-methyl-2-pyrrolidinone (2X3 mL), then a 1.0 M solution of benzotriazole-1-yl-oxy-tris-pyrrolidino-phosphonium hexafluorophosphate in 1-methyl-2-pyrrolidinone (0.2 mL, 0.2 mmol) was added, followed by a 0.7 M solution of the amine in 1-methyl-2-pyrrolidinone (0.3 mL, 0.21 mmol) and a 1.0 M solution of the diisopropylethylamine in 1-methyl-2-pyrrolidinone (0.4 mL, 0.4 mmol). The vessel was capped under nitrogen, and the reaction mixture was agitated on a tabletop shaker for 24 hours. Then, the resin was drained and washed with 1-methyl-2-pyrrolidinone (3X1 mL). The reaction with the amine was repeated by addition of a 1.0 M solution of benzotriazole-1-yl-oxy-tris-pyrrolidino-phosphonium

-565-

hexafluorophosphate in 1-methyl-2-pyrrolidinone (0.2 mL, 0.2 mmol), a 0.7 M solution of the amine in 1-methyl-2-pyrrolidinone (0.3 mL, 0.21 mmol) and a 1.0 M solution of the diisopropylethylamine in 1-methyl-2-pyrrolidinone (0.4 mL, 0.4 mmol). The vessel was capped under nitrogen, and the reaction mixture was agitated an additional 8 hours. Then, the resin was drained and washed with the following sequence of solvents: 1-methyl-2-pyrrolidinone, 1:1 1-methyl-2-pyrrolidinone/water, water, 1:9 acetic acid/water, methanol, methylene chloride (3X1 mL each solvent).

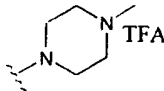
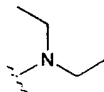

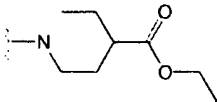
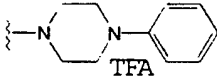
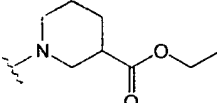
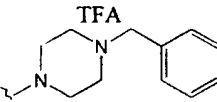
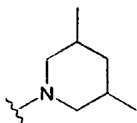
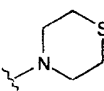
The following hydroxamic acids were synthesized using Resin Xd and the indicated amine following the procedure outlined in Step 14 followed by release from the polymer using the procedure in Step 3:



20

Example	amine	R	MS (ES) m/z
324	propylamine		447 (M+H)
325	piperidine		473 (M+H)
326	morpholine		475 (M+H)

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327	1-methyl-piperazine		488 (M+H)
328	diethylamine		461 (M+H)
329	pyrrolidine		459 (M+H)
330	ethyl isonipecotate		545 (M+H)
331	1-phenyl-piperazine		550 (M+H)
332	ethyl nipecotate		545 (M+H)
333	1-benzyl-piperazine		564 (M+H)
334	3,5-dimethyl-piperidine		501 (M+H)
335	thiomorpholine hydrochloride		491 (M+H)

5 Example 336: Preparation of 4-[[4-[4-[[[(9H-fluoren-9-ylmethoxy)carbonyl]amino]-1-piperidinyl]-phenyl] sulfonyl]  
10 tetrahydro-2H-pyran-4-carboxylic acid

Part A: To a solution of the product of Example 11, Part B (10.0 g, 34.7 mmol) in 1-methyl-2-pyrrolidinone (70 mL) was added 4-(N-t-



-567-

butoxycarbonylamino)piperidine (10.43 g, 52.1 mmol), followed by diisopropylethylamine (6.0 mL, 34.7 mmol). The resulting mixture was heated at 80 degrees Celsius for 24 hours and then cooled to room temperature. The crude mixture was poured into 700 mL water, and the cloudy aqueous layer was extracted with ethyl acetate (3X150 mL). The combined organic layers were washed with 5% potassium hydrogen sulfate (2X150 mL) and brine (2X150 mL), dried over magnesium sulfate, and concentrated *in vacuo* to give the crude ester as a white foamy solid (13.04 g, 78%).

Part B: To a solution of the ester of part A (5.74 g, 11.9 mmol) in a mixture of ethanol (80 mL) and tetrahydrofuran (40 mL) was added 2 N sodium hydroxide (60 mL; 120 mmole). The resulting solution was heated to 60 degrees Celsius for 1 hour and then cooled to room temperature. The solution was concentrated *in vacuo*, and the residue was partitioned between water (300 mL) and ethyl acetate (200 mL). The aqueous layer was separated and acidified with concentrated hydrogen chloride to pH 2. A white precipitate formed, which was collected by vacuum filtration and dried *in vacuo* to give the carboxylic acid as a white solid (4.88 g, 88%).

Part C: To a suspension of the carboxylic acid from part B (4.88 g, 10.4 mmol) in methylene chloride (35 mL) was added trifluoroacetic acid (35 mL), resulting in dissolution of the solid. After fifteen minutes at ambient temperature, the solution was concentrated *in vacuo*. The product was triturated with diethyl ether to give the amino acid as an off-white solid (4.92 g, 98%).

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Part D: A suspension of the amino acid from part C (4.92 g, 10.21 mmol) in a mixture of 10% sodium carbonate/water (35 mL), water (100 mL) and dioxane (100 mL) was cooled in an ice bath. To the cooled suspension is added a solution of 9-fluorenylmethylsuccinimidyl carbonate (3.79 g, 11.23 mmol) in dioxane (50 mL) dropwise. After complete addition, the ice bath was removed, and the mixture warmed to room temperature. After one hour, the solution was concentrated *in vacuo*, and the residue was partitioned between water (300 mL) and ethyl acetate (200 mL). The aqueous layer was separated and acidified with concentrated hydrogen chloride to pH 2. The white precipitate formed, which was collected by vacuum filtration, washed with hexanes and dried *in vacuo* to give the title compound as a white solid (5.46 g, 91%).

Step 15: Preparation of Resin XVI.

Part A: Following the procedure outlined in Step 1 above, the product of Example 336 (2.4 g, 4.06 mmol) was reacted with Resin I (1.7 g, 2.03 mmol) to give Resin XV as a tan polymeric solid (2.82 g). Theoretical loading on polymer was 0.71 mmol/g.

Part B: Resin XV from part A above (2.76 g, 1.96 mmol) was suspended in a 1:4 piperidine/dimethylformamide solution (20 mL) in a fritted reaction vessel and agitated on a tabletop shaker for 5 minutes. The resin was drained, and an additional volume of a 1:4 mixture of piperidine/dimethylformamide (20 mL) was added to the vessel. The slurry was agitated at room temperature for 30 minutes. After this, the resin was drained

-569-

and washed with dimethylformamide, methanol, and methylene chloride (3X20 mL each solvent). After drying in vacuo, the title resin was obtained as a tan polymeric solid (2.30 g).

5

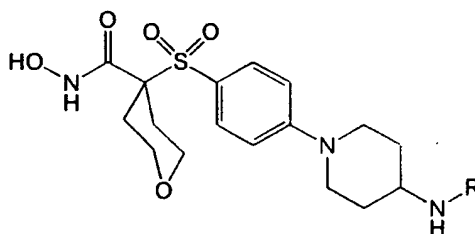
Step 16: Acylation/Sulfonylation  
of Resin XVI.

In a fritted reaction vessel, Resin XVI (50 mg, 0.043 mmol) was washed with 1-methyl-2-pyrrolidinone (2X1 mL). Then, a 0.22 M solution of the acylating or sulfonylating reagent in 1-methyl-2-pyrrolidinone (1 mL, 0.22 mmol) was added to the resin followed by diisopropylethylamine (40 uL, 0.22 mmol). The vessel was capped under nitrogen and  
15 agitated on a tabletop shaker at room temperature for 16 hours. Then, the resin was drained and washed with 1-methyl-2-pyrrolidinone, water, 1:9 acetic acid/water, methanol and methylene chloride (3X1 mL each solvent).

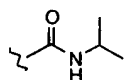
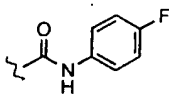
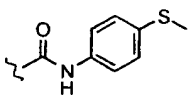
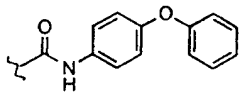
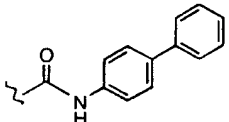
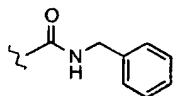
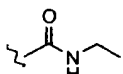
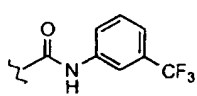
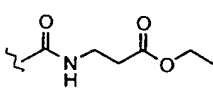
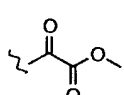
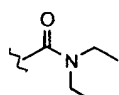

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The following hydroxamic acids were synthesized from Resin XVI using Step 16 with the indicated acylating or sulfonylating reagent, followed by release from the polymer using the  
25 reaction conditions in Step 3.

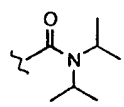
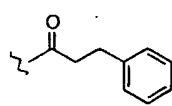
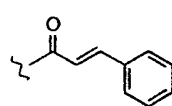
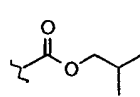
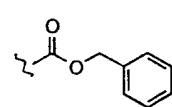
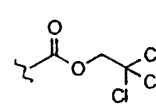
-570-



Example	Acylating or Sulfonylating Reagent	R	MS (ES) m/z
337	benzoyl chloride		488.2 (M+ H)
338	nicotinyl chloride-HCl		489.2 (M+ H)
339	benzenesulfonyl chloride		462 (M+H)
340	1-methyl- imidazole-4- sulfonyl chloride		528.2 (M+ H)
341	acetyl chloride		426.2 (M+ H)
342	methanesulfonyl chloride		462.1 (M+ H)
343	cyclohexyl isocyanate		509 (M+H)
344	2-methoxyphenyl isocyanate		533 (M+H)
345	phenyl isocyanate		503 (M+H)
346	beta-phenylethyl isocyanate		531 (M+H)

347	isopropyl isocyanate		469 (M+H)
348	4-fluorophenyl isocyanate		521 (M+H)
349	4-(methylthio)- phenyl isocyanate		549 (M+H)
350	4-phenoxyphenyl isocyanate		595 (M+H)
351	4-phenylphenyl isocyanate		579 (M+H)
352	benzyl isocyanate		517 (M+H)
353	ethyl isocyanate		455 (M+H)
354	alpha,alpha,alpha- trifluoro-m-tolyl isocyanate		571 (M+H)
355	ethyl 3-isocyanato- propionate		527 (M+H)
356	methyl oxalyl chloride		470 (M+H)
357	diethylcarbamyl chloride		483 (M+H)
358	dimethylcarbamyl chloride		455 (M+H)
359	diisopropyl carbamyl chloride		511 (M+H)

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360	hydrocinnamoyl chloride		516 (M+H)
361	cinnamoyl chloride		514 (M+H)
361	isobutyl- chloroformate		484 (M+H)
363	benzylchloro- formate		518 (M+H) ,
364	trichloroethyl- chloroformate		558 (M+H)

Example 365-371:

5

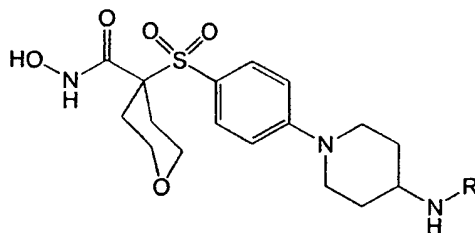
Step 17: Reductive Alkylation of  
Resin XVI.

In a fritted reaction vessel, Resin XVI (50 mg, 0.043 mmol) was washed methylene chloride (2X1 mL). Then, a 1 M solution of the aldehyde or ketone in methylene chloride (1 mL, 1 mmol) was added to the resin. The vessel was capped under nitrogen and agitated on a tabletop shaker at room temperature for 3 hours. The resin was drained and washed with methylene chloride (3X1 mL). Then, the resin was retreated with the 1 M solution of the aldehyde or ketone in methylene chloride (1 mL, 1 mmol). The resin was drained and washed with methylene chloride (3X1 mL each solvent). Then, a 1 M solution of

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sodium triacetoxyborohydride in 1-methyl-2-pyrrolidinone (1 mL, 1 mmol) was added to the resin, and the reaction was stirred overnight. After this, the resin was drained and washed with 1-methyl-2-pyrrolidinone, methanol, water, 1:9 acetic acid/water, methanol and methylene chloride (3X1 mL each solvent).

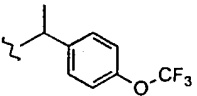
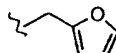
The following hydroxamic acids were synthesized from Resin XVI using Step 17 with the indicated aldehyde or ketone, followed by release from the polymer using the conditions in Step 3.



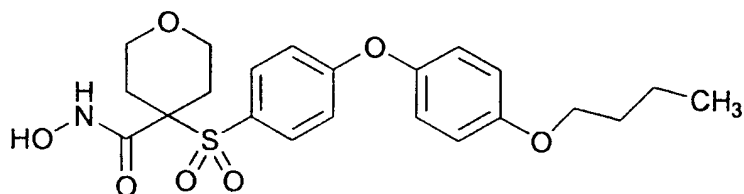
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Example Number	Aldehyde or Ketone	R	MS (ES) m/z
365	butyraldehyde		440 (M+H)
366	acetone		426 (M+H)
367	N-propyl-4-pyridone		509 (M+H)
368	4-t-butylcyclohexanone		522 (M+H)
369	2-pyridine-carboxaldehyde		475 (M+H)

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370	4'-(trifluoromethoxy)-acetophenone		572 (M+H)
371	2-furaldehyde		464 (M+H)

Example 372: Preparation of 4-[[4-(4-butoxyphenoxy)-phenyl]sulfonyl]tetrahydro-N-hydroxy-2H-pyran-4-carboxamide



Part A: To a solution of the product of Example 55 (3.1 g, 8 mmol) in dimethylacetamide (20 mL) was added cesium carbonate (7.28 g, 24 mmol) and 4-butoxyphenol (2.66 g, 16 mmol). The slurry was stirred at ninety five degrees Celsius for nineteen hours. The reaction was concentrated *in vacuo*. The residue was taken up in ethyl acetate, washed with brine, dried over Na<sub>2</sub>SO<sub>4</sub>, filtered, and concentrated *in vacuo*. Chromatography (on silica, ethyl acetate/hexanes) provided the substituted THP hydroxamate as an off-white foam (3.96 g, 93%). HRMS (ES+) M+NH<sub>4</sub><sup>+</sup> calculated for C<sub>27</sub>H<sub>35</sub>N<sub>1</sub>O<sub>8</sub> S<sub>1</sub>F : 551.24, found 551.24.

Part B: To a solution of the THP hydroxamate from part A (3.9 g, 7.3 mmol) in 1,4-dioxane (20 mL) was added 4N HCl dioxane solution (20



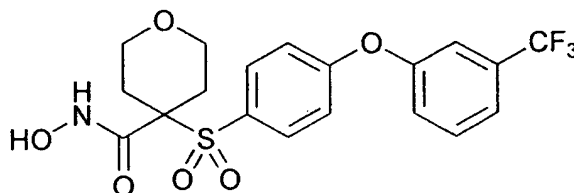
-575-

mL) and methanol (20 mL). After fifteen minutes at ambient temperature the reaction was diluted with ethyl acetate and washed with water, dried over  $\text{Na}_2\text{SO}_4$ , filtered, and concentrated in vacuo. The product was recrystallized (acetone/hexanes) to give the title compound as a white solid (2.75 g, 84%).

HRMS (ES+)  $\text{M} + \text{H}^+$  calculated for  $\text{C}_{22}\text{H}_{27}\text{N}_1\text{O}_7\text{S}_1$  : 450.16, found 450.16.

10

Example 373: Preparation of tetrahydro-N-hydroxy-4-  
[[4-[3-(trifluoromethyl)phenoxy]phenyl]-  
sulfonyl]-2H-pyran-4-carboxamide



15

Part A: To a solution of the product of Example 55 (3.1 g, 8 mmol) in dimethylacetamide (20 mL) was added cesium carbonate (7.28 g, 24 mmol) and m-(trifluoromethyl)phenol (1.95 mL, 16 mmol). The slurry was stirred at ninety five degrees Celsius for nineteen hours. The reaction was concentrated in vacuo. The residue was taken up in ethyl acetate, washed with brine, dried over  $\text{Na}_2\text{SO}_4$ , filtered, and concentrated in vacuo. Chromatography (on silica, ethyl acetate/hexanes) provided the substituted THP hydroxamate as a white foam (4.1 g, 97%). HRMS (ES+)  $\text{M} + \text{H}^+$  calculated for  $\text{C}_{24}\text{H}_{26}\text{N}_1\text{O}_7\text{S}_1\text{F}_3$  : 530.15, found 530.14.

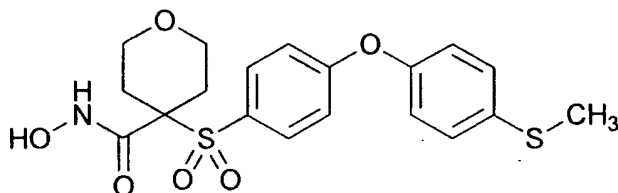
-576-

Part B: To a solution of the THP hydroxamate from part A (3.9 g, 7.4 mmol) in 1,4-dioxane (20 mL) was added 4N HCl dioxane solution (20 mL) and methanol (20 mL). After fifteen minutes at ambient temperature, the reaction was diluted with ethyl acetate and washed with water, dried over Na<sub>2</sub>SO<sub>4</sub>, filtered, and concentrated *in vacuo*. The product was recrystallized (acetone/hexanes) to give the title compound as a white solid (1.9 g, 58%).

10 HRMS (ES+) M+ H<sup>+</sup> calculated for C<sub>19</sub>H<sub>18</sub>N<sub>1</sub>O<sub>6</sub>S<sub>1</sub>F<sub>3</sub> : 446.09, found 446.09.

Example 374: Preparation of tetrahydro-N-hydroxy-4-[[4-[4-(methylthio)phenoxy]phenyl]sulfonyl]-2H-pyran-4-carboxamide

15



Part A: To a solution of the product of Example 55 (3.1 g, 8 mmol) in dimethylacetamide (20 mL) was added cesium carbonate (7.28 g, 24 mmol) and 4-(methylthio)phenol (2.24 g, 16 mmol). The slurry was stirred at ninety five degrees Celsius for twenty four hours. The reaction was concentrated *in vacuo*.

25 The residue was taken up in ethyl acetate, washed with brine, dried over Na<sub>2</sub>SO<sub>4</sub>, filtered, and concentrated *in vacuo*. Chromatography (on silica, ethyl acetate/hexanes) provided the substituted THP hydroxamate as a white foam (4.1 g, 100%). HRMS (ES+)

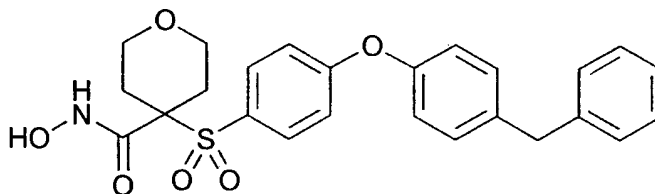
-577-

M+H<sup>+</sup> calculated for C<sub>24</sub>H<sub>29</sub>N<sub>1</sub>O<sub>7</sub> S<sub>2</sub>: 508.15, found 508.15.

Part B: To a solution of the THP hydroxamate from part A (4.0 g, 7.9 mmol) in 1,4-dioxane (20 mL) was added 4N HCl dioxane solution (20 mL) and methanol (20 mL). After fifteen minutes at ambient temperature, the reaction was diluted with ethyl acetate and washed with water, dried over Na<sub>2</sub>SO<sub>4</sub>, filtered, and concentrated in vacuo. The product was recrystallized (acetone/hexanes) to give the title compound as a white solid (1.9 g, 57%).

HRMS (ES+) M+ H<sup>+</sup> calculated for C<sub>19</sub>H<sub>21</sub>N<sub>1</sub>O<sub>6</sub>S<sub>2</sub> : 424.09, found 424.09.

Example 375: Preparation of tetrahydro-N-hydroxy-4-[[4-[4-(phenylmethyl)phenoxy]phenyl]-sulfonyl]-2H-pyran-4-carboxamide



20

Part A: To a solution of the product of Example 55 (2.7 g, 7 mmol) in dimethylacetamide (15 mL) was added cesium carbonate (6.84 g, 21 mmol) and 4-hydroxydiphenylmethane (2.8 g, 14 mmol). The slurry was stirred at ninety degrees Celsius for nineteen hours. The reaction was concentrated in vacuo. The residue was taken up in ethyl acetate, washed with brine, dried over Na<sub>2</sub>SO<sub>4</sub>, filtered, and concentrated in vacuo. Chromatography (on silica,

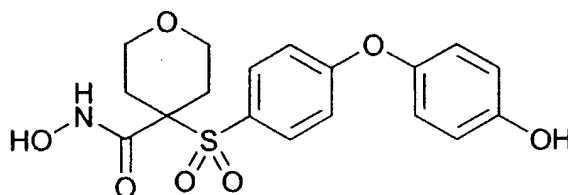
-578-

ethyl acetate/hexanes) provided the substituted THP hydroxamate as a light yellow foam (3.7 g, 96%). HRMS (ES+)  $M+H^+$  calculated for  $C_{30}H_{33}N_1O_7$   $S_1$ : 552.21, found 552.21.

5                   Part B: To a solution of the THP hydroxamate from part A (3.5 g, 6.4 mmol) in 1,4-dioxane (16 mL) was added 4N HCl dioxane solution (16 mL) and methanol (16 mL). After fifteen minutes at ambient temperature the reaction was diluted with  
10 ethyl acetate and washed with water, dried over  $Na_2SO_4$ , filtered, and concentrated *in vacuo*. The product was recrystallized (acetone/hexanes) to give the title compound as a white solid (1.95 g, 67%).  
HRMS (ES+)  $M+H^+$  calculated for  $C_{25}H_{25}N_1O_6S_1$  :  
15 468.15, found 468.15.

Example 376: Preparation of tetrahydro-N-hydroxy-4-  
[[4-(4-hydroxyphenoxy)phenyl]sulfonyl]-  
2H-pyran-4-carboxamide

20



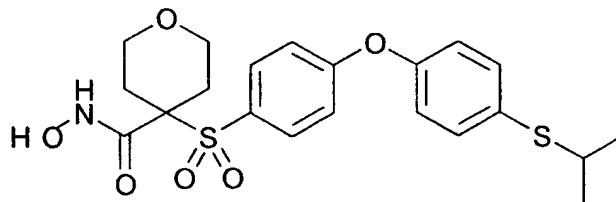
Part A: To a solution of the product of  
Example 55) (2.7 g, 7 mmol) in dimethylacetamide (20  
25 mL) was added cesium carbonate (6.84 g, 21 mmol) and  
4-(benzyloxy)phenol (2.8 g, 14 mmol). The slurry was  
stirred at ninety five degrees Celsius for six hours.  
The reaction was concentrated *in vacuo*. The residue  
was taken up in ethyl acetate, washed with brine,

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dried over  $\text{Na}_2\text{SO}_4$ , filtered, and concentrated in vacuo. Chromatography (on silica, ethyl acetate/hexanes) provided the substituted THP hydroxamate as a white foam (3.94 g, 99%). HRMS (ES+)  $\text{M} + \text{NH}_4^+$  calculated for  $\text{C}_{30}\text{H}_{33}\text{N}_1\text{O}_8 \text{ S}_1$  : 585.23, found 585.23.

Part B: To a solution of the THP hydroxamate from part A (1.5 g, 2.64 mmol) in glacial acetic acid (5 mL) was added concentrated HCl (5 mL) and the reaction was heated to sixty degrees Celsius for twenty minutes. The reaction was cooled, diluted with water (100 mL) and extracted with ethyl acetate. The ethyl acetate extract was washed with water three times, brine, dried over  $\text{Na}_2\text{SO}_4$ , filtered, and concentrated in vacuo. The product was recrystallized (acetone/hexanes) to give the title compound as a white solid (810 mg, 78%). HRMS (ES+)  $\text{M} + \text{NH}_4^+$  calculated for  $\text{C}_{18}\text{H}_{19}\text{N}_1\text{O}_7 \text{ S}_1$  : 468.15, found 468.15.

Example 377: Preparation of tetrahydro-N-hydroxy-4-[[4-[4-[(1-methylethyl)thio]phenoxy]-phenyl]-sulfonyl]-2H-pyran-4-carboxamide



Part A: To a suspension of 4-hydroxythiophenol (5.0 g, 40 mmol) and potassium

carbonate (8.0 g, 58 mmol) in dimethylformamide (70 mL) was added 2-iodopropane (7.0 g, 41 mmol). The slurry was stirred at ambient temperature for one hour. The reaction was concentrated *in vacuo*. The  
5 residue was taken up in ethyl acetate, washed two times with water, 10% HCl solution, brine, dried over Na<sub>2</sub>SO<sub>4</sub>, filtered, and concentrated *in vacuo*. Chromatography (on silica, ethyl acetate/hexanes) provided the substituted phenol as a clear colorless  
10 oil (5.1 g, 76%).

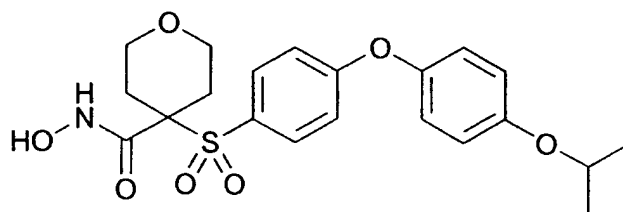
Part B: To a solution of the product of Example 55 (3.1 g, 8 mmol) in dimethylacetamide (20 mL) was added cesium carbonate (7.28 g, 24 mmol) and the phenol from part A (2.7 g, 16 mmol). The slurry  
15 was stirred at ninety five degrees Celsius for fifteen hours. The reaction was concentrated *in vacuo*. The residue was taken up in ethyl acetate, washed with brine, dried over Na<sub>2</sub>SO<sub>4</sub>, filtered, and concentrated *in vacuo*. Chromatography (on silica,  
20 ethyl acetate/hexanes) provided the substituted THP hydroxamate as a white foam (4.15 g, 97%). HRMS (ES+) M+ H<sup>+</sup> calculated for C<sub>26</sub>H<sub>33</sub>N<sub>1</sub>O<sub>7</sub> S<sub>2</sub> : 536.18, found 538.17.

Part C: To a solution of the THP  
25 hydroxamate from part A (3.9 g, 7.3 mmol) in 1,4-dioxane (18 mL) was added 4N HCl dioxane solution (18 mL) and methanol (18 mL). After fifteen minutes at ambient temperature, the reaction was diluted with ethyl acetate and washed with water, dried over  
30 Na<sub>2</sub>SO<sub>4</sub>, filtered, and concentrated *in vacuo*. The product was recrystallized (acetone/hexanes) to give the title compound as an off white solid (2.32 g,

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71%). HRMS (ES+)  $M + H^+$  calculated for  $C_{21}H_{25}N_1O_6S_2$  :  
452.12, found 452.12.

Example 378: Preparation of tetrahydro-N-hydroxy-4-  
5 [[4-[4-(1-methylethoxy)phenoxy)phenyl]-  
sulfonyl]-2H-pyran-4-carboxamide



Part A: To a solution of benzoic acid, 4-  
10 hydroxyphenylester (8.57 g, 40 mmol) in  
dimethylacetamide (65 mL) was added potassium  
carbonate (8.3 g, 60 mmol) and 2-iodopropane (5 mL,  
50 mmol). The slurry was stirred at sixty five  
degrees Celsius for one hour. The reaction was  
15 concentrated *in vacuo*. The residue was taken up in  
ethyl acetate, washed with water three times, brine,  
dried over  $Na_2SO_4$ , filtered, and concentrated *in vacuo*  
to yield the isopropoxy compound as a light gray  
solid (9.7g, 95%).

20 Part B: To a slurry of the isopropoxy  
compound from part A (9.7 g, 38 mmol) in 1,4-dioxane  
(20 mL) and water (20 mL) was added 2.5N sodium  
hydroxide solution (26 mL, 65 mmol). The slurry was  
stirred at sixty degrees Celsius for four hours. The  
25 reaction was cooled and 6N hydrochloric acid solution  
was added until the pH=5. The reaction was extracted  
with methylene chloride. The organic layer was  
washed with 5% ammonium hydroxide solution four  
times, water, brine, dried over  $Na_2SO_4$ , filtered, and

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concentrated *in vacuo* to yield the phenol as an amber oil (5.4 g, 94%).

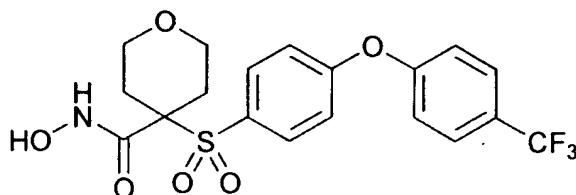
Part C: To a solution of the product of Example 55 (3.1 g, 8 mmol) in dimethylacetamide (20 mL) was added cesium carbonate (7.28 g, 24 mmol) and the phenol from part B (2.4 g, 16 mmol). The slurry was stirred at ninety five degrees Celsius for twenty one hours. The reaction was concentrated *in vacuo*. The residue was taken up in ethyl acetate, washed with water three times, brine, dried over Na<sub>2</sub>SO<sub>4</sub>, filtered, and concentrated *in vacuo*. Chromatography (on silica, ethyl acetate/hexanes) provided the substituted THP hydroxamate as an off white foam (3.65 g, 88%). HRMS (ES+) M+ H<sup>+</sup> calculated for C<sub>26</sub>H<sub>33</sub>N<sub>1</sub>O<sub>8</sub> S<sub>1</sub> : 520.20, found 520.20.

Part D: To a solution of the THP hydroxamate from part C (3.5 g, 6.7 mmol) in 1,4-dioxane (17 mL) was added 4N HCl dioxane solution (17 mL) and methanol (17 mL). After fifteen minutes at ambient temperature, the reaction was diluted with ethyl acetate and washed with water, dried over Na<sub>2</sub>SO<sub>4</sub>, filtered, and concentrated *in vacuo*. The product was recrystallized (acetone/hexanes) to give the title compound as an off white solid (2.2 g, 80%). HRMS (ES+) M+ H<sup>+</sup> calculated for C<sub>21</sub>H<sub>25</sub>N<sub>1</sub>O<sub>7</sub>S<sub>1</sub> : 436.14, found 436.14.

Example 379: Preparation of tetrahydro-N-hydroxy-4-  
[[4-[4-[(trifluoromethyl)phenoxy]-  
phenyl]-sulfonyl]-2H-pyran-4-  
carboxamide



-583-



Part A: In dry equipment under nitrogen, sodium hydride (60% oil dispersion) (11. g, 0.275  
5 mol) was added to a solution of 4-[4-(trifluoromethyl)phenoxy]-phenol (50.0 g, 0.197 mol) in dry dimethylformamide (150 mL) at zero degrees Celsius. After fifteen minutes, a solution of dimethylthiocarbamoyl chloride (32.0 g, 0.259 mol) in  
10 dry dimethylformamide (100 mL) was added. The reaction was stirred at ambient temperature for sixteen hours. The reaction was poured onto 10% hydrochloric acid solution (1 L). Vacuum filtration of the resulting precipitate provided the thiono  
15 compound as a white solid (67.0 g, 100%).

Part B: The thiono compound from part A (70 g, 0.2 mol) was heated to three hundred seventeen degrees Celsius for thirty minutes behind a safety shield. The reaction exothermed to three hundred  
20 thirty degrees Celsius. The heat was removed and the reaction came to ambient temperature to yield the thiocarbamate as a brown solid (70 g, 100%).

Part C: To a solution of the thiocarbamate from part B (65.0 g, 0.19 mol) in methanol (510 mL)  
25 with a subsurface nitrogen stream was added 2.5N sodium hydroxide solution (160 mL, 0.4 mol). The slurry was stirred at seventy four degrees Celsius for two hours. The reaction was cooled and the methanol removed *in vacuo*. The residue was diluted

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with water (100 mL) and extracted with diethyl ether four times. A subsurface stream of nitrogen was added to the aqueous solution and sodium chloroacetate (22.2 g, 0.19 mol) was added. The reaction was stirred at an ambient temperature and after thirty minutes the nitrogen stream was removed. After twelve hours, the solution was cooled and 6N hydrochloric acid was added until the pH=1. The slurry was extracted with ethyl acetate four times. The combined ethyl acetate extracts were washed with 0.1N hydrochloric acid, water, brine, dried over Na<sub>2</sub>SO<sub>4</sub>, filtered and dried in vacuo to give the thioacetic acid as a tan solid (61.0 g, 98%).

Part D: To a solution of the thioacetic acid from part C (54.45g, 0.166 mol) in tetrahydrofuran (370 mL) was added water (45 mL) and Oxone® (306 g, 0.498 mol) at twenty degrees Celsius. An exotherm to forty two degrees Celsius was noted. After two hours, the reaction was filtered and the cake was washed well with tetrahydrofuran and then water (250 mL) was added to the filtrate. The filtrate was concentrated in vacuo. The slurry was extracted with ethyl acetate four times. The combined extracts were washed with water three times, brine, dried over MgSO<sub>4</sub>, filtered, and concentrated in vacuo to give the sulfone as a beige solid (60.0 g, 100%).

Part E: A solution of the sulfone from part D (119.52 g, 0.332 mol) in methanol (660 mL) and 4N hydrochloric acid in dioxane solution (20 mL) was stirred at ambient temperature for twelve hours. The reaction was heated to a boil and cooled slowly to ambient temperature. The resulting crystals were

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filtered, washed well with cold methanol, and dried to give the methyl ester as a white solid (89.4 g, 72%).

Part F: To a solution of the methyl ester from part E (64.5 g, 0.180 mol) in dimethylacetamide (360 mL) was added potassium carbonate (66.8 g, 0.48 mol), bis-(2-bromoethyl)ether (40 mL, 0.305 mol), 4-dimethylaminopyridine (1.1 g, 9 mmol), and tetrabutylammonium bromide (2.9 g, 9 mmol). The reaction was stirred overnight at ambient temperature. The reaction was slowly poured into 1N HCl (500 mL). The resulting precipitate was filtered, washed with water, then hexanes. The solid was recrystallized from methanol to give the pyran compound as a white solid (62.8 g, 79%). MS (ES+)  $M+NH_4^+$  calculated for  $C_{20}H_{19}O_{56}S_1F_3$  : 462.12, found 462.12.

Part G: In dry equipment under nitrogen, the pyran compound from part F (64.0 g, 0.144 mol) was dissolved in dry tetrahydrofuran (250 mL) and a solution of potassium trimethylsilonate (55.9 g, 0.432 mol) in dry tetrahydrofuran (40 mL) was added at ambient temperature. After two hours, water (200 mL) was added and the solution concentrated *in vacuo*. The slurry was extracted with ethyl acetate to remove unreacted starting material. The aqueous solution was treated with 6N HCl until pH=1. The slurry was extracted with ethyl acetate and the combined extracts washed with water, brine, dried over  $Na_2SO_4$ , filtered, and concentrated *in vacuo*. The residue was heated in diethyl ether, the resulting solid filtered and dried to give the carboxylic acid as a white

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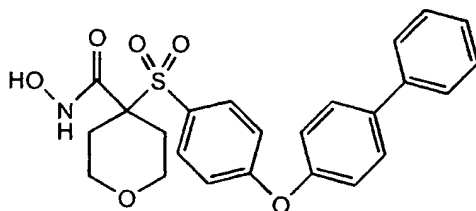
solid (56.3 g, 91%). HRMS (ES+)  $M+NH_4^+$  calculated for  $C_{19}H_{17}O_6 S_1F_3$  : 448.10, found 448.10.

Part H: In dry equipment under nitrogen, the carboxylic acid from part G (49.0 g, 0.114 mol) was dissolved in dry dimethylformamide (280 mL) and the remaining reagents were added to the solution in the following order: N-hydroxybenzotriazole hydrate (18.5 g, 0.137 mol), N-methylmorpholine (37.5 mL, 0.342 mol), O-(tetrahydro-2H-pyran-2-yl)hydroxylamine (41.3 g, 0.353 mol), and 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride 30.6 g, 0.160 mol). After four hours at ambient temperature, the reaction was concentrated *in vacuo*. The residue was taken up in ethyl acetate, washed with water, 5%  $KHSO_4$ , saturated  $NaHCO_3$ , brine, dried over  $Na_2SO_4$ , filtered, and concentrated *in vacuo* to give the THP hydroxamate as a white foam (62.6 g, 100%). HRMS (ES+)  $M+NH_4^+$  calculated for  $C_{24}H_{26}NO_7S_1F_3$  : 547.17, found 547.17.

Part I: To a solution of the THP hydroxamate from part H (58.5 g, 0.11 mol) in 1,4-dioxane (280 mL) was added 4N HCl dioxane solution (280 mL) and methanol (280 mL). After fifteen minutes at ambient temperature, the reaction was diluted with ethyl acetate and washed with water, dried over  $Na_2SO_4$ , filtered, and concentrated *in vacuo*. The product was recrystallized (acetone/hexanes) to give the title compound as a white solid (42.79 g, 87%) HRMS (ES+)  $M+NH_4^+$  calculated for  $C_{19}H_{18}NO_6S_1F_3$  : 463, found 463.

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Example 380: Preparation of 4-[[4-([1,1'-biphenyl]-4-yloxy)phenyl]sulfonyl]tetrahydro-N-hydroxy-2H-pyran-4-carboxamide



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Part A: To a solution of the product of Example 55 (2.0 g, 5.2 mmol) in dimethylacetamide (8 mL) was added 4-phenylphenol (Aldrich, 1.3 g, 7.8 mmol) followed by cesium carbonate (6.8 g, 20.8 mmol). The reaction was heated at ninety-five degrees Celsius for five hours. Stripping the dimethylacetamide *in vacuo* afforded a brown solid (5.3 g, quantitative). Chromatography (reverse phase, C-18, acetonitrile/water) gave the THP-protected biphenyl product in solution.

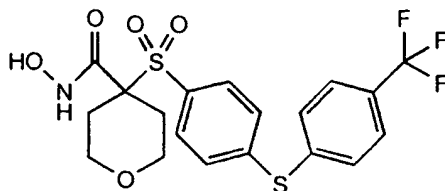
Part B: To the collected THP-protected diphenyl product from A in acetonitrile/ water (50 mL) was slowly added 10% HCl<sub>aq</sub> (100 mL). After stirring overnight (about eighteen hours), the acetonitrile was stripped. The resultant precipitate was collected, giving the title compound as a white solid (2.0 g, 83%). MS (FAB) M<sup>+</sup>H calculated for C<sub>24</sub>H<sub>23</sub>NO<sub>6</sub>S: 454, found 454.

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Example 381: Preparation of tetrahydro-N-hydroxy-4-  
[[4-[[4-(trifluoromethyl)phenyl]thio]  
phenyl]-sulfonyl]-2H-pyran-4-  
carboxamide

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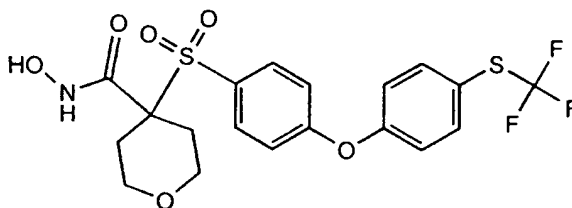


Part A: To a solution of the product of  
Example 55 (2.0 g, 5.2 mmol) in dimethylacetamide (6  
10 mL) was added 4-trifluoromethylthiophenol (Maybridge,  
2.0 g, 11.2 mmol), followed by potassium carbonate  
(2.9 g, 20.8 mmol). The reaction was heated at  
sixty-five degrees Celsius for twelve hours.  
Stripping the dimethylacetamide *in vacuo* afforded a  
15 brown solid (6.5 g, quantitative). Chromatography  
(reverse phase, C-18, acetonitrile/water) gave the  
THP-protected trifluoromethyl product in solution.

Part B: To the solution of the crude THP-  
protected trifluoromethyl product from in  
20 acetonitrile/water (40 mL) was slowly added 10% HCl<sub>aq</sub>  
(100 mL). After stirring overnight (about eighteen  
hours), the acetonitrile was stripped. The resultant  
precipitate was collected, giving the title compound  
as a tan solid (0.75 g, 31 %). MS (FAB) M<sup>+</sup>H  
25 calculated for C<sub>19</sub>H<sub>18</sub>F<sub>3</sub>NO<sub>5</sub>S<sub>2</sub>: 462, found 462.

Example 382: Preparation of Tetrahydro-N-hydroxy-4-  
[[4-[4-[(trifluoromethyl)thio]phenoxy]  
phenyl]-sulfonyl]-2H-pyran-4-  
carboxamide

5



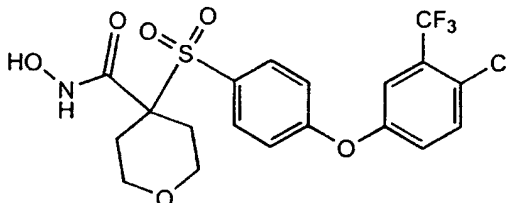
Part A: To a solution of the product of  
10 Example 55 (2.0 g, 5.2 mmol) in dimethylacetamide (6  
mL) was added 4-(trifluoromethylthio)thiophenol  
(Aldrich, 1.5 g, 7.8 mmol) followed by cesium  
carbonate (6.8 g, 20.8 mmol). After adding a  
catalytic amount of potassium fluoride, the reaction  
15 was heated at ninety-five degrees Celsius for twelve  
hours. Stripping the dimethylacetamide *in vacuo*  
afforded a brown solid (7.2 g, quantitative).  
Chromatography (reverse phase, C-18,  
acetonitrile/water) gave the THP-protected  
20 trifluoromethylthio product in solution.

Part B: To the solution of the crude THP-  
protected trifluoromethylthio product from A in  
acetonitrile/water (40 mL) was slowly added 10% HCl<sub>aq</sub>  
(100 mL). After stirring overnight (about eighteen  
25 hours), the acetonitrile was stripped. The resultant  
precipitate was collected, giving the title compound  
as a tan solid (0.60 g, 24 %). MS (FAB) M<sup>+</sup>H  
calculated for C<sub>19</sub>H<sub>18</sub>F<sub>3</sub>NO<sub>6</sub>S<sub>2</sub>: 476, found 476.

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Example 380: Preparation of 4-[[4-[4-chloro-3-(trifluoro-methyl)phenoxy]phenyl]sulfonyl]-tetrahydro-N-hydroxy-2H-pyran-4-carboxamide

5



Part A: To a solution of the product of  
10 Example 55 (2.0 g, 5.2 mmol) in dimethylacetamide (6 mL) was added 4-chloro-3-trifluoromethylphenol (Avocado, 1.5 g, 7.8 mmol) followed by cesium carbonate (6.8 g, 20.8 mmol). The reaction was heated at ninety-five degrees Celsius for twelve  
15 hours. Stripping the dimethylacetamide in vacuo afforded a brown solid (7.6 g, quantitative). Chromatography (reverse phase, C-18, acetonitrile/water) gave the THP-protected product in solution.

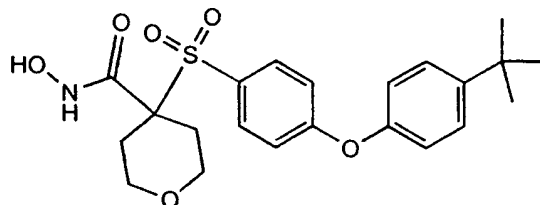
20 Part B: To the solution of the crude THP-protected product from in acetonitrile/water (40 mL) was slowly added 10% HCl<sub>aq</sub> (100 mL). After stirring overnight (about eighteen hours), the acetonitrile was stripped. The resultant precipitate was  
25 collected, giving the title compound as a white solid (0.92 g, 37 %). MS (FAB) M<sup>+</sup>H calculated for C<sub>19</sub>H<sub>17</sub>ClF<sub>3</sub>NO<sub>6</sub>S: 480, found 480.



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Example 384: Preparation of 4-[[4-[4-(1,1-dimethylethyl)-phenoxy]phenyl]sulfonyl]tetrahydro-N-hydroxy-2H-pyran-4-carboxamide

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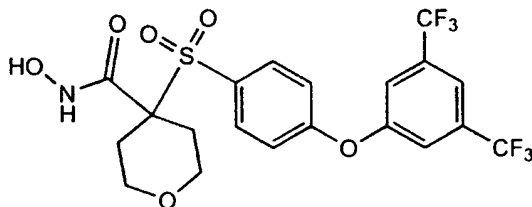


Part A: To a solution of the product of  
10 Example 55 (5.0 g, 12.9 mmol) in dimethylacetamide  
(25 mL) was added 4-*t*-butylphenol (Avocado, 2.9 g,  
19.4 mmol) followed by cesium carbonate (20.4 g,  
20.862.5 mmol). The reaction was heated at ninety-  
five degrees Celsius for twelve hours. Stripping the  
15 dimethylacetamide *in vacuo* afforded a brown solid  
(9.4 g, quantitative). Chromatography (reverse  
phase, C-18, acetonitrile/water) gave the THP-  
protected product in solution.

Part B: To the solution of the crude THP-  
20 protected product from in acetonitrile/water (60 mL)  
was slowly added 10% HCl<sub>aq</sub> (100 mL). After stirring  
overnight (about eighteen hours), the acetonitrile  
was stripped. The resultant precipitate was  
collected, giving the title compound as a white solid  
25 (0.28 g, 5 %). MS (FAB) M<sup>+</sup>H calculated for C<sub>22</sub>H<sub>27</sub>NO<sub>6</sub>S:  
434, found 434.

Example 385: Preparation of 4-[[4-[3,5-bis(trifluoromethyl)phenoxy]phenyl]sulfonyl]tetrahydro-N-hydroxy-2H-pyran-4-carboxamide

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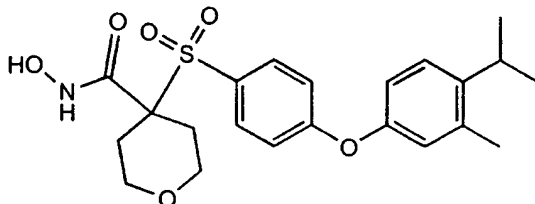
Part A: To a solution of the product of  
10 Example 55 (3.0 g, 7.7 mmol) in dimethylacetamide  
(15 mL) was added 3,5-ditrifluoromethylphenol (2.9 g,  
19.4 mmol) followed by cesium carbonate (20.4 g,  
20.862.5 mmol). The reaction was heated at ninety-  
five degrees Celsius for twelve hours. Stripping the  
15 dimethylacetamide in vacuo afforded a brown solid  
(14.7 g, quantitative). Chromatography (reverse  
phase, C-18, acetonitrile/water) gave the THP-  
protected product in solution.

Part B: To the solution of the crude THP-  
20 protected product from in acetonitrile water (60 mL)  
was slowly added 10% HCl<sub>aq</sub> (100 mL). After stirring  
overnight (about eighteen hours), the acetonitrile  
was stripped. The resultant precipitate was  
collected, giving the title compound as a white solid  
25 (1.2 g, 31 %). MS (FAB) M<sup>+</sup>H calculated for C<sub>20</sub>H<sub>17</sub>  
F<sub>6</sub>NO<sub>6</sub>S: 514, found 514.

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Example 386: Preparation of tetrahydro-N-hydroxy-  
4-[[4-[3-methyl-4-(1-methylethyl)  
phenoxy]phenyl]-sulfonyl]-2H-  
pyran-4-carboxamide

5



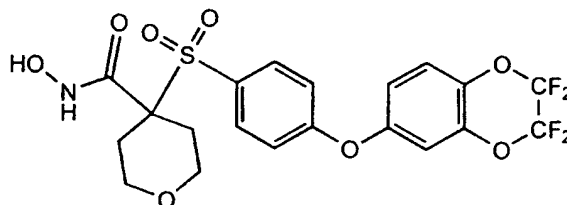
Part A: To a solution of the product of  
Example 55 (4.0 g, 10.3 mmol ) in dimethylacetamide  
10 (20 mL) was added 4-isopropyl-3-methylphenol  
(Aldrich, 2.3 g, 15.5 mmol) followed by cesium  
carbonate (16.8 g, 51.5 mmol). The reaction was  
heated at ninety-five degrees Celsius for twelve  
hours. Stripping the dimethylacetamide *in vacuo*  
15 afforded a brown solid (18.3 g, quantitative).  
Chromatography (reverse phase, C-18,  
acetonitrile/water) gave the THP-protected product  
in solution.

Part B: To the solution of the crude THP-  
20 protected product from A in acetonitrile/water (40  
mL) was slowly added 10% HCl<sub>aq</sub> (100 mL). After  
stirring overnight (about eighteen hours), the  
acetonitrile was stripped. The resultant precipitate  
was collected, giving the title compound as a tan  
25 solid (1.8 g, 40 %). MS (FAB) M<sup>+</sup>H calculated for  
C<sub>22</sub>H<sub>27</sub>F<sub>3</sub>NO<sub>6</sub>S: 432, found 432.

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Example 387: Preparation of Tetrahydro-N-hydroxy-4-  
[[4-[(2,2,3,3-tetrafluoro-2,3-dihydro-  
1,4-benzodioxin-6-yl]oxy]phenyl]  
sulfonyl]-2H-pyran-4-carboxamide

5



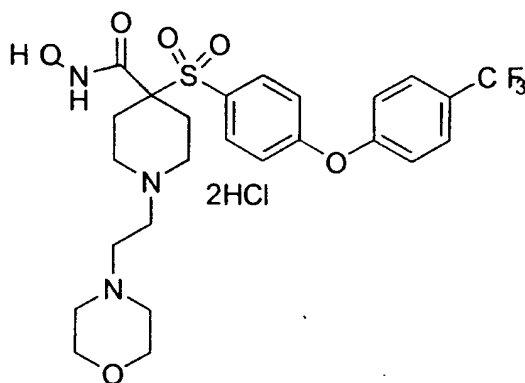
Part A: To a solution of the product of  
Example 55 (5.0 g, 12.9 mmol ) in dimethylacetamide  
10 (25 mL) was added 2,2,3,3-tetrafluoro-6-  
hydroxybenzodioxene (Oakwood, 4.3 g, 19.4 mmol)  
followed by cesium carbonate (21.0 g, 64.5 mmol).  
The reaction was heated at ninety-five degrees  
Celsius for five hours. Stripping the  
15 dimethylacetamide in vacuo afforded a brown solid  
(11.3 g, quantitative) Chromatography (reverse  
phase, C-18, acetonitrile/water) gave the THP-  
protected product in solution.

Part B: To the collected THP-protected  
20 product from A in acetonitrile/water (50 mL) was  
slowly added 10% HCl<sub>aq</sub> (100 mL). After stirring  
overnight (about eighteen hours), the acetonitrile  
was stripped. The resultant precipitate was  
collected, giving the title compound as a white  
25 solid (3.5 g, 54%). MS (FAB) M<sup>+</sup>H calculated for  
C<sub>20</sub>H<sub>17</sub>F<sub>4</sub>NO<sub>8</sub>S: 506, found 506.

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Example 388: Preparation of N-hydroxy-1-[2-(4-morpholinyl)-ethyl]-4-[[4-[4-(trifluoromethyl)phenoxy]-phenyl]sulfonyl]-4-piperidinecarboxamide, dihydrochloride

5



Part A: To a suspension of 4-bromopiperidine  
10 hydrobromide (107.0 g, 0.436 mol) in tetrahydrofuran  
(1 L) was slowly added triethylamine (122 mL, 0.872  
mol) followed by di-tert-butyl dicarbonate (100 g,  
0.458 mol), which was added in several portions. The  
resulting mixture was stirred at ambient temperature  
15 for 22 hours then filtered and concentrated *in vacuo*.  
The solids were washed with hexanes and then  
collected by filtration to give the Boc-piperidine  
compound as an amber oil (124 g, >100 %).

Part B: To a solution of 4-fluorophenol (50.0  
20 g, 0.390 mol) in acetone (400 mL), degassed with N<sub>2</sub>,  
was added Cs<sub>2</sub>CO<sub>3</sub> (159 g, 0.488 mol). After degassing  
the resulting mixture with N<sub>2</sub> for 5 minutes, the Boc-  
piperidine compound of part A (85.9 g, 0.325 mol) was  
added. The resulting mixture was stirred at ambient  
25 temperature for 18 hours and then filtered through a

pad of Celite®, washing with acetone. The filtrate was concentrated *in vacuo* to provide the sulfide as a tan residue (98.5 g, 97%).

Part C: To a solution of the sulfide of part B (8.00 g, 25.7 mmol) in dichloromethane (90 mL) and methanol (15 mL) was added monoperoxyphthalic acid magnesium salt hexahydrate (19.1 g, 38.6 mmol) in two portions. The resulting mixture was stirred at ambient temperature for 1.5 hours and then filtered. The filtrate was washed with saturated NaHCO<sub>3</sub> and then with saturated NaCl. The combined aqueous layers were extracted with dichloromethane (100 mL). The combined organic layers were dried over Na<sub>2</sub>SO<sub>4</sub> and then concentrated *in vacuo*. The resulting solids were washed with hexanes then dissolved in dichloromethane and filtered through a pad of Celite®, washing with dichloromethane. The filtrate was concentrated *in vacuo* and recrystallization from ethyl acetate provided the sulfone as a white crystalline solid (4.45 g, 50%).

Part D: To a solution of sulfone of part C (7.00 g, 20.4 mmol) in N,N-dimethylformamide (40 mL) was added Cs<sub>2</sub>CO<sub>3</sub> (19.9 g, 61.2 mmol) and  $\alpha,\alpha,\alpha$ -trifluoro-p-cresol (3.97 g, 24.5 mmol). The resulting mixture was heated at eighty degrees Celsius for 16 hours. After cooling to ambient temperature the reaction mixture was concentrated *in vacuo*. The resulting residue was treated with H<sub>2</sub>O and the solids were collected by filtration. The solids were then washed with hexanes then methanol to provide the biaryl ether as a tan solid (8.60 g, 87%).

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Part E: To a solution of the biaryl ether of part D (8.59 g, 17.7 mmol) in tetrahydrofuran (100 mL), cooled to zero degrees Celsius, was slowly added lithium bis(trimethylsilyl)amide (22.0 mL, 1.0M in tetrahydrofuran, 22.0 mmol), at such a rate that the temperature of the reaction never exceeded one degree Celsius. The resulting mixture was stirred at zero degrees Celsius for 1 hour then a solution of methyl chloroformate (2.05 mL, 26.6 mmol) in tetrahydrofuran (5.0 mL) was slowly added, at such a rate that the temperature of the reaction mixture never exceeded four degrees Celsius. After the addition was complete, the mixture was slowly permitted to warm to ambient temperature. Saturated  $\text{NH}_4\text{Cl}$  (50 mL) was added and the tetrahydrofuran was removed *in vacuo*. Water (50 mL) was added to the residue which was then extracted with ethyl acetate. The combined organic layers were washed with saturated  $\text{NaCl}$  and dried over  $\text{Na}_2\text{SO}_4$ . Recrystallization from methanol provided the methyl ester as a pale yellow crystalline solid (7.66 g, 80%).

Part F: To a solution of the methyl ester of part E (7.66 g, 14.1 mmol) in dioxane (30 mL) and methanol (10 mL) was added a solution of 4N  $\text{HCl}$  in dioxane (10 mL, 40 mmol). After stirring at ambient temperature for 2 hours additional 4N  $\text{HCl}$  in dioxane (10 mL, 40 mmol) was added. After stirring at ambient temperature for 2.5 hours, the reaction mixture was concentrated *in vacuo* to provide the amine as an off-white solid (6.80 g, >100%).

Part G: To a suspension of the amine of part F (3.00 g, 6.25 mmol) in acetonitrile (20 mL) was added  $\text{K}_2\text{CO}_3$  (3.46 g, 25.0 mmol), 4-(2-chloroethyl)morpholine

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hydrochloride (1.22 g, 6.56 mmol) and a catalytic amount of NaI. The resulting mixture was heated at reflux for 22 hours. After cooling to ambient temperature, the reaction mixture was filtered  
5 through a pad of Celite®, washing with ethyl acetate. The filtrate was concentrated in vacuo to provide the morpholinyl ethyl amine as a tan solid (3.45 g, >100%).

Part H: To a solution of the morpholinyl ethyl  
10 amine of part G (3.45 g, 6.25 mmol) in tetrahydrofuran (60 mL) was added potassium trimethylsilanolate (1.60 g, 12.50 mmol). After stirring at ambient temperature for 25 hours, H<sub>2</sub>O was added. The reaction mixture was then neutralized (pH  
15 7) with 1N HCl. The tetrahydrofuran was removed in vacuo and the resulting precipitate was collected by filtration and washed with diethyl ether to provide the amino acid as an off-white solid (2.87 g, 85%).

Part I: To a suspension of the amino acid of  
20 part H (2.87 g, 5.29 mmol) in dichloromethane (25 mL) was added N-methylmorpholine (1.74 mL, 15.9 mmol), O-(tetrahydropuranyl) hydroxylamine (0.682 g, 5.82 mmol) and PyBroP® (2.96 g, 6.35 mmol). After stirring at ambient temperature for 19 hours  
25 additional N-methylmorpholine (0.872 mL, 7.94 mmol), O-(tetrahydropuranyl) hydroxylamine (0.310 g, 2.65 mmol) and PyBroP® (1.48 g, 3.17 mmol) were added. The resulting mixture was stirred at ambient temperature for 3 hours and then concentrated in  
30 vacuo. The residue was partitioned between ethyl acetate and H<sub>2</sub>O. The organic layers were washed with saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Chromatography (on silica, methanol/chloroform) provided the

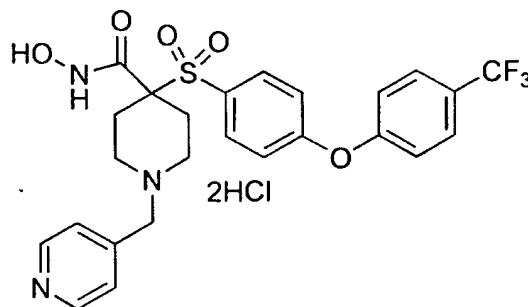


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protected hydroxamate as an off-white solid (2.62 g, 77%).

Part J: To a solution of the protected hydroxamate of part I (2.62 g, 4.08 mmol) in dioxane (9 mL) and methanol (3 mL) was added a solution of 4N HCl in dioxane (10 mL, 40.0 mmol). The resulting mixture was stirred at ambient temperature for 2 hours and then diethyl ether (20 mL) was added. The resulting solids were collected by filtration to give the title compound as an off-white solid (2.31 g, 90%). MS  $MH^+$  calculated for  $C_{25}H_{31}O_6N_3SF_3$ : 558, found 558.

Example 389: Preparation of N-hydroxy-1-(4-pyridinylmethyl)-4-[[4-[4-(trifluoromethyl)phenoxy]phenyl]-sulfonyl]-4-piperidinecarboxamide, dihydrochloride



20

Part A: To a suspension of the amine of part F, Example 388 (1.50 g, 3.13 mmol) in acetonitrile (10 mL) were added  $K_2CO_3$  (1.73 g, 12.5 mmol) and 4-picolyl chloride hydrochloride (0.565 g, 3.44 mmol). After stirring at reflux for 21.5 hours, the reaction mixture was filtered through a pad of Celite®,

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washing with ethyl acetate. The filtrate was concentrated *in vacuo*. Chromatography (on silica, ethyl acetate/hexanes) provided the picolyl amine as a clear gum (1.44 g, 86%).

5        Part B: To a solution of the picolyl amine of part A (1.44 g, 2.69 mmol) in tetrahydrofuran (20 mL) was added potassium trimethylsilanolate (0.690 g, 5.38 mmol). The resulting mixture was stirred at ambient temperature for 20 hours and then the  
10        tetrahydrofuran was removed by blowing N<sub>2</sub> over the reaction mixture. Water (8 mL) was added and the reaction mixture was neutralized (pH 7) with 2N HCl. The resulting precipitate was collected by filtration to provide the amino acid as a white solid (1.31 g,  
15        94%).

          Part C: To a suspension of the amino acid of part B (1.31 g, 2.52 mmol) in N,N-dimethylformamide (10 mL) was added 1-hydroxybenzotriazole (0.408 g, 3.02 mmol), N-methylmorpholine (0.831 mL, 7.56 mmol),  
20        O-(tetrahydropuranyl) hydroxylamine (0.443 g, 3.78 mmol) and 1-3-[(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (0.676 g, 3.53 mmol). The resulting mixture was stirred at ambient temperature for 3 days then concentrated *in vacuo*.  
25        The residue was partitioned between H<sub>2</sub>O and ethyl acetate. The combined organic layers were washed with saturated NaHCO<sub>3</sub>, saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Chromatography (on silica, ethyl acetate/hexanes) provided the protected hydroxamate as  
30        a white foam (1.24 g, 79%).

          Part D: To a solution of the protected hydroxamate of part C (1.24 g, 2.00 mmol) in dioxane (6 mL) and methanol (2 mL) was added a solution of 4N

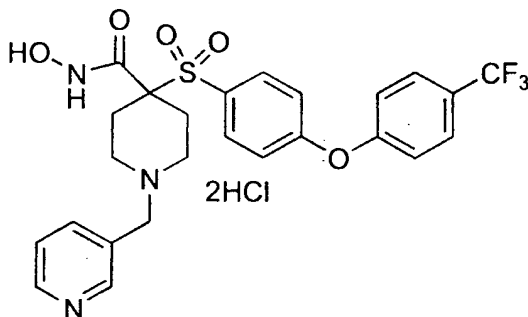
-601-

HCl in dioxane (5.00 mL, 20.0 mmol). After stirring at ambient temperature for 2.5 hours the reaction mixture was concentrated in vacuo. The resulting foam was then treated again with a solution of 4N HCl in dioxane (3 mL) for 15 minutes then diethyl ether was added and the resulting precipitate was collected by filtration to provide the title compound as an off-white solid (1.04 g, 85%). MS  $MH^+$  calculated for  $C_{25}H_{25}O_5N_3SF_3$ : 536, found 536.

10

Example 390: Preparation of N-hydroxy-1-(3-pyridinylmethyl)-4-[[4-[4-trifluoromethyl)phenoxy]phenyl]-sulfonyl]-4-piperidinecarboxamide, dihydrochloride

15



Part A: To a suspension of the amine of part F, Example 388 (1.00 g, 2.08 mmol) in acetonitrile (10 mL) was added  $K_2CO_3$  (1.15 g, 8.33 mmol) and 3-picolyl chloride hydrochloride (0.375 g, 2.29 mmol). After stirring at reflux for 12 hours, the reaction mixture was filtered through a pad of Celite®, washing with ethyl acetate. The filtrate was concentrated in vacuo. Chromatography (on silica, ethyl

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acetate/hexanes) provided the picolyl amine as a pale yellow foam (0.740 g, 67%).

Part B: To a solution of the picolyl amine of part A (0.740 g, 1.38 mmol) in tetrahydrofuran (10 mL) was added potassium trimethylsilanolate (0.355 g, 2.77 mmol). The resulting mixture was stirred at ambient temperature for 17 hours, then additional potassium trimethylsilanolate (0.044 g, 0.343 mmol) was added and the resulting mixture was stirred at ambient temperature for 2 hours. The tetrahydrofuran was removed by blowing N<sub>2</sub> over the reaction mixture. Water (5 mL) was added and the reaction mixture was neutralized (pH 7) with 2N HCl. The resulting precipitate was collected by filtration and dried by concentration *in vacuo* with acetone to provide the amino acid as an off-white solid (0.700 g, 97%).

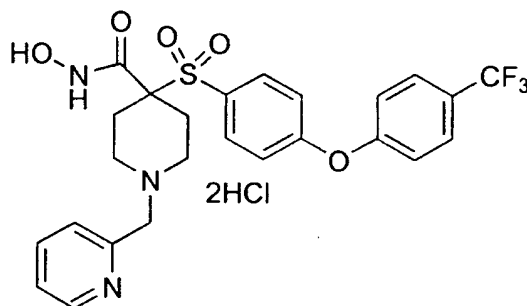
Part C: To a suspension of the amino acid of part B (0.700 g, 1.34 mmol) in N,N-dimethylformamide (10 mL) was added 1-hydroxybenzotriazole (0.218 g, 1.61 mmol), N-methylmorpholine (0.442 mL, 4.02 mmol), O-(tetrahydropuranyl) hydroxylamine (0.235 g, 2.01 mmol) and 1-3-[(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (0.360 g, 1.88 mmol). The resulting mixture was stirred at ambient temperature for 23 hours, then concentrated *in vacuo*. The residue was partitioned between H<sub>2</sub>O and ethyl acetate. The combined organic layers were washed with H<sub>2</sub>O, saturated NaHCO<sub>3</sub>, saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Chromatography (on silica, ethyl acetate/hexanes) provided the protected hydroxamate as an off-white foam (0.500 g, 60%).

Part D: To a solution of the protected hydroxamate of part C (0.500 g, 0.807 mmol) in

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dioxane (1.5 mL) and methanol (0.5 mL) was added a solution of 4N HCl in dioxane (3.0 mL, 12.00 mmol). After stirring at ambient temperature for 2 hours, diethyl ether was added and the resulting precipitate  
5 was collected by filtration to provide the title compound as a yellow solid (0.363 g, 74%). MS MH<sup>+</sup> calculated for C<sub>25</sub>H<sub>25</sub>O<sub>5</sub>N<sub>3</sub>SF<sub>3</sub>: 536, found 536.

Example 391: Preparation of N-hydroxy-1-(2-pyridinylmethyl)-4-[[4-[4-(trifluoromethyl)phenoxy]phenyl]-sulfonyl]-4-piperidinecarboxamide,  
10 dihydrochloride



15

Part A: To a suspension of the amine of part F, Example 388 (1.26 g, 2.63 mmol) in acetonitrile (10 mL) was added K<sub>2</sub>CO<sub>3</sub> (1.45 g, 10.5 mmol) and 2-picolyl  
20 chloride hydrochloride (0.475 g, 2.89 mmol). After stirring at reflux for 12 hours, the reaction mixture was filtered through a pad of Celite®, washing with ethyl acetate. The filtrate was concentrated in vacuo. Chromatography (on silica, ethyl  
25 acetate/hexanes) provided the picolyl amine as an amber oil (1.40 g, 99%).

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Part B: To a solution of the picolyl amine of part A (1.40 g, 2.62 mmol) in tetrahydrofuran (20 mL) was added potassium trimethylsilanolate (0.672 g, 5.24 mmol). The resulting mixture was stirred at ambient temperature for 15 hours. The tetrahydrofuran was removed by blowing N<sub>2</sub> over the reaction mixture. H<sub>2</sub>O (5 mL) was added and the reaction mixture was neutralized (pH 7) with 2N HCl. The resulting precipitate was collected by filtration and dried by concentration *in vacuo* with acetonitrile to provide the amino acid as an off-white solid (1.07 g, 79%).

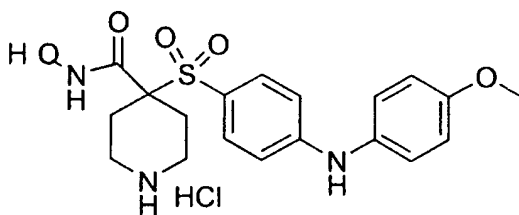
Part C: To a suspension of the amino acid of part B (1.07 g, 2.06 mmol) in N,N-dimethylformamide (10 mL) was added 1-hydroxybenzotriazole (0.333 g, 2.47 mmol), N-methylmorpholine (0.679 mL, 6.18 mmol), O-(tetrahydropuranyl) hydroxylamine (0.362 g, 3.09 mmol) and 1-3-[(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (0.553 g, 2.88 mmol). The resulting mixture was stirred at ambient temperature for 19 hours, then concentrated *in vacuo*. The residue was partitioned between H<sub>2</sub>O and ethyl acetate. The combined organic layers were washed with H<sub>2</sub>O, saturated NaHCO<sub>3</sub>, saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Chromatography (on silica, methanol/dichloromethane) provided the protected hydroxamate as a white solid (1.03 g, 81%).

Part D: To a solution of the protected hydroxamate of part C (1.03 g, 1.66 mmol) in dioxane (3.0 mL) and methanol (1.0 mL) was added a solution of 4N HCl in dioxane (3.0 mL, 12.00 mmol). After stirring at ambient temperature for 1.5 hours, diethyl ether was added and the resulting precipitate

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was collected by filtration to provide the title compound as a pale pink solid (0.970 g, 96%). MS  $MH^+$  calculated for  $C_{25}H_{25}O_5N_3SF_3$ : 536, found 536.

- 5    Example 392: Preparation of N-hydroxy-4-[[4-[(4-methoxyphenyl)amino]phenyl]sulfonyl]-4-piperidinecarboxamide, monohydrochloride



10

Part A: To the ester of part C, Example 91 (1.00 g, 2.17 mmol) was added  $Cs_2CO_3$  (0.990 g, 3.04 mmol), BINAP (0.061 g, 0.098 mmol), tris(dibenzylideneacetone)dipalladium (0) (0.060 g, 0.07 mmol), p-anisidine (0.320 g, 2.60 mmol) and toluene (4 mL). The resulting mixture was heated to one hundred degrees Celsius for 22 hours. After cooling to ambient temperature, diethyl ether was added and the mixture was filtered through a pad of Celite®, washing with ethyl acetate. The filtrate was concentrated *in vacuo*. Chromatography (on silica, ethyl acetate/hexane) provided the aniline as an orange foam (0.810 g, 74%).

Part B: To a solution of the aniline of part A (0.780 g, 1.55 mmol) in tetrahydrofuran (4.0 mL) was added potassium trimethylsilanolate (0.238 g, 1.86 mmol). The resulting mixture was stirred at ambient temperature for 17 hours, and then additional potassium trimethylsilanolate (0.020 g, 0.1955mmol)

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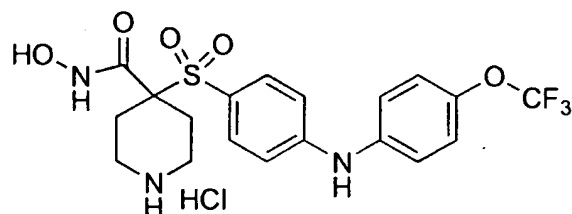
was added. After stirring at ambient temperature for 24 hours additional potassium trimethylsilanolate (0.040 g, 0.310 mmol) was added. After stirring at ambient temperature for 26 hours, the solvent was removed by blowing N<sub>2</sub> over the mixture. To a suspension of the residue in dichloromethane (10 mL) was added N-methylmorpholine (0.511 mL, 4.65 mmol), O-(tetrahydropuranyl) hydroxylamine (0.218 g, 1.86 mmol), followed by PyBroP® (1.08 g, 2.33 mmol). The resulting mixture was stirred at ambient temperature for 2 days and then concentrated in vacuo. The residue was partitioned between H<sub>2</sub>O and ethyl acetate. The combined organic layers were washed with saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Chromatography (on silica, ethyl acetate/hexane) provided the protected hydroxamate as an off-white solid (0.600 g, 66%).

Part C: To a solution of the protected hydroxamate of part B (0.580 g, 0.984 mmol) in dioxane (3 mL) and methanol (1 mL) was added a solution of 4N HCl in dioxane (2.5 mL, 10.0 mmol). The resulting mixture was stirred at ambient temperature for 1 hour, then diethyl ether (10 mL) was added. The solids were collected by filtration to give the title compound as a white solid (0.437 g, 100%). MS MH<sup>+</sup> calculated for C<sub>19</sub>H<sub>24</sub>O<sub>5</sub>N<sub>3</sub>S: 406, found 406.

Example 393: Preparation of N-hydroxy-4-[[4-[[4-(trifluoromethoxy)phenyl]amino]phenyl]-sulfonyl]-4-piperidinecarboxamide, monohydrochloride



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Part A: To a solution of the ester of part C, Example 91 (3.27 g, 7.09 mmol) was added Cs<sub>2</sub>CO<sub>3</sub> (3.23 g, 9.92 mmol), BINAP (0.066 g, 0.107 mmol),  
5 tris(dibenzylideneacetone)-dipalladium (0) (0.065 g, 0.071 mmol), 4-trifluoro-methoxyaniline (1.15 mL, 8.51 mmol) and toluene (14 mL). The resulting mixture was heated to one hundred degrees Celsius for  
10 22 hours. After cooling to ambient temperature, the mixture was filtered through a pad of Celite®, washing with ethyl acetate, and the filtrate was concentrated in vacuo. Chromatography (on silica, ethyl acetate/hexane) provided the aniline as a tan  
15 solid (3.59 g, 91%).

Part B: To a solution of the aniline of part A (1.03 g, 1.84 mmol) in tetrahydrofuran (10 mL) was added potassium trimethylsilanolate (0.331 g, 2.58 mmol). The resulting mixture was stirred at ambient  
20 temperature for 24 hours, and then additional potassium trimethylsilanolate (0.118 g, 0.092 mmol) was added. After stirring at ambient temperature for 24 hours, the solvent was removed by blowing N<sub>2</sub> over the mixture. H<sub>2</sub>O was added and the reaction mixture  
25 was acidified (pH 3) with 1N HCl. The aqueous reaction mixture was extracted with ethyl acetate and the combined organic layers were washed with saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Concentration

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*in vacuo* provided the acid as a tan solid (1.01 g, 100%).

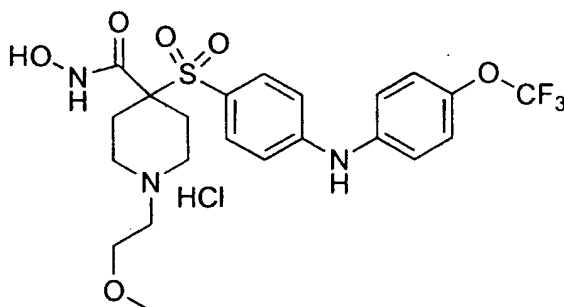
Part C: To a suspension of the acid of part B (1.00 g, 1.84 mmol) in N,N-dimethylformamide (10 mL) was added 1-hydroxybenzotriazole (0.298 g, 2.21 mmol), N-methylmorpholine (0.607 mL, 5.52 mmol), O-(tetrahydropuranyl) hydroxylamine (0.323 g, 2.76 mmol) and 1-3-[(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (0.494 g, 2.58 mmol). The resulting mixture was stirred at ambient temperature for 17 hours then concentrated *in vacuo*. The residue was partitioned between H<sub>2</sub>O and ethyl acetate. The combined organic layers were washed with H<sub>2</sub>O, saturated NaHCO<sub>3</sub>, saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Chromatography (on silica, ethyl acetate/hexanes) provided the protected hydroxamate as a white solid (0.960 g, 81%).

Part D: To a solution of the protected hydroxamate of part C (0.960 g, 1.49 mmol) in dioxane (3 mL) and methanol (1 mL) was added a solution of 4N HCl in dioxane (4.0 mL, 16.0 mmol). The resulting mixture was stirred at ambient temperature for 2.5 hours. The solvent was then removed by blowing N<sub>2</sub> over the reaction mixture. Diethyl ether (20 mL) was added and the precipitate was collected by filtration to give the title compound as a pale pink solid (0.716 g, 100%). MS MH<sup>+</sup> calculated for C<sub>19</sub>H<sub>21</sub>O<sub>5</sub>N<sub>3</sub>SF<sub>3</sub>: 460, found 460.

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Example 394: Preparation of N-hydroxy-1-(2-methoxyethyl)-4-[[4-[[4-(trifluoromethoxy)phenyl]amino]phenyl]sulfonyl]-4-piperidinecarboxamide, monohydrochloride

5



Part A: To a solution of the aniline of  
10 part A, Example 392 (2.55 g, 4.57 mmol) in dioxane  
(9.0 mL) and methanol (3.0 mL) was added a solution  
of 4N HCl in dioxane (10 mL, 40 mmol). After  
stirring at ambient temperature for 2 hours, the  
reaction mixture was concentrated in vacuo to provide  
15 the amine as a tan solid (2.36 g, >100%).

Part B: To a suspension of the amine of part A  
(1.50 g, 3.03 mmol) in acetonitrile (12 mL) was added  
K<sub>2</sub>CO<sub>3</sub> (1.26 g, 9.09 mmol) and 2-bromoethyl methyl  
ether (0.313 mL, 3.33 mmol). After stirring at  
20 reflux for 23 hours, Cs<sub>2</sub>CO<sub>3</sub> (2.96 g, 9.09 mmol) was  
added. After 6 hours at reflux, the reaction mixture  
was filtered through a pad of Celite®, washing with  
dichloromethane. The filtrate was concentrated in  
vacuo. Chromatography (on silica, methanol/  
25 dichloromethane) provided the methoxy ethyl amine as  
a tan solid (1.13 g, 72%).

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Part C: To a solution of the methoxy ethyl amine of part B (1.13 g, 2.19 mmol) in tetrahydrofuran (20 mL) was added potassium trimethylsilanolate (0.561 g, 4.38 mmol). The resulting mixture was stirred at ambient temperature for 18 hours, and then additional potassium trimethylsilanolate (0.140 g, 1.09 mmol) was added. After stirring at ambient temperature for 5 hours, the solvent was removed by blowing N<sub>2</sub> over the mixture. Water (8 mL) was added and the reaction mixture was neutralized (pH 7) with 1N HCl. The solids were collected by filtration and dried by concentration *in vacuo* with acetonitrile to provide the amino acid as an off-white solid (0.900 g, 82%).

Part D: To a suspension of the amino acid of part C (0.900 g, 1.79 mmol) in N,N-dimethylformamide (8.0 mL) was added 1-hydroxybenzotriazole (0.290 g, 2.15 mmol), N-methylmorpholine (0.590 mL, 5.37 mmol), O-(tetrahydropuranyl) hydroxylamine (0.315 g, 2.69 mmol) and 1-3-[(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (0.480 g, 2.51 mmol). The resulting mixture was stirred at ambient temperature for 16 hours then concentrated *in vacuo*. The residue was partitioned between H<sub>2</sub>O and ethyl acetate. The combined organic layers were washed with H<sub>2</sub>O, saturated NaHCO<sub>3</sub>, saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Chromatography (on silica, methanol/dichloromethane) provided the protected hydroxamate as an off-white solid (0.870 g, 81%).

Part E: To a solution of the protected hydroxamate of part D (0.870 g, 1.45 mmol) in dioxane (3 mL) and methanol (1 mL) was added a solution of 4N HCl in dioxane (10 mL, 40.0 mmol). The resulting

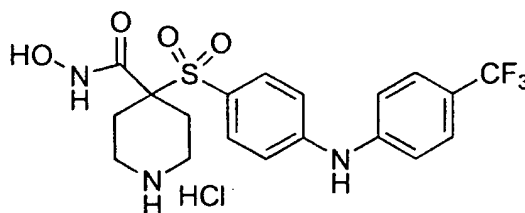
-611-

mixture was stirred at ambient temperature for 2.0 hours. The reaction mixture was concentrated in vacuo and then treated again with 4N HCl (3 mL) for 30 minutes. The solvent was then removed by blowing N<sub>2</sub> over the reaction mixture. Diethyl ether (30 mL) was added, and the precipitate was collected by filtration to give the title compound as a pale pink solid (0.771 g, 96%). MS MH<sup>+</sup> calculated for C<sub>22</sub>H<sub>27</sub>O<sub>6</sub>N<sub>3</sub>SF<sub>3</sub>: 518, found 518.

10

Example 395: Preparation of N-hydroxy-4-[[4-[[4-(trifluoromethyl)phenyl]amino]phenyl]-sulfonyl]-4-piperidinecarboxamide, monohydrochloride

15



Part A: To a solution of the ester of part C, Example 91 (3.16 g, 6.85 mmol) was added Cs<sub>2</sub>CO<sub>3</sub> (3.13 g, 9.59 mmol), BINAP (0.064 g, 0.103 mmol), tris(dibenzylideneacetone)-dipalladium (0) (0.063 g, 0.069 mmol),  $\alpha,\alpha,\alpha$ -trifluoro-methylaniline (1.03 mL, 8.22 mmol) and toluene (14 mL). The resulting mixture was heated to one hundred degrees Celsius for 17 hours. After cooling to ambient temperature, the mixture was filtered through a pad of Celite®, washing with dichloromethane, and the filtrate was concentrated in vacuo. Chromatography (on silica,

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ethyl acetate/hexane) provided the aniline as a pale orange foam (3.08 g, 83%).

Part B: To a solution of the aniline of part A (1.00 g, 1.84 mmol) in tetrahydrofuran (10 mL) was added potassium trimethylsilanolate (0.473 g, 3.69 mmol). The resulting mixture was stirred at ambient temperature for 25 hours then the solvent was removed by blowing N<sub>2</sub> over the mixture. Water was added, and the reaction mixture was acidified (pH 3) with 1N HCl. The aqueous layer was extracted with ethyl acetate and the combined organic layers were washed with saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Concentration *in vacuo* provided the acid as an orange foam (1.00 g, >100%).

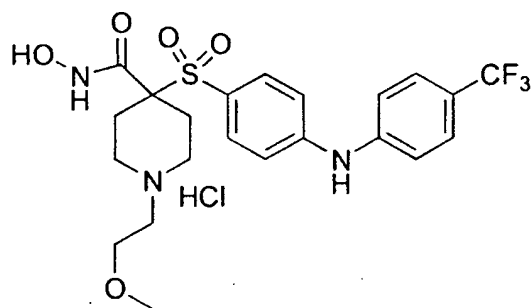
Part C: To a suspension of the acid of part B (0.972 g, 1.84 mmol) in N,N-dimethylformamide (10 mL) was added 1-hydroxybenzotriazole (0.298 g, 2.21 mmol), N-methylmorpholine (0.607 mL, 5.52 mmol), O-(tetrahydropuranyl) hydroxylamine (0.323 g, 2.76 mmol) and 1-3-[(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (0.494 g, 2.58 mmol). The resulting mixture was stirred at ambient temperature for 18 hours, then concentrated *in vacuo*. The residue was partitioned between H<sub>2</sub>O and ethyl acetate. The combined organic layers were washed with H<sub>2</sub>O, saturated NaHCO<sub>3</sub>, saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Chromatography (on silica, ethyl acetate/hexanes) provided the protected hydroxamate as a white solid (0.970 g, 84%).

Part D: To a solution of the protected hydroxamate of part C (0.950 g, 1.51 mmol) in dioxane (3 mL) and methanol (1 mL) was added a solution of 4N HCl in dioxane (4.0 mL, 16.0 mmol). The resulting

-613-

mixture was stirred at ambient temperature for 1.5 hours. Diethyl ether (20 mL) was added and the precipitate was collected by filtration to give the title compound as a white solid (0.630 g, 87%). MS  
5  $MH^+$  calculated for  $C_{19}H_{21}O_4N_3SF_3$ : 444, found 444.

Example 396: Preparation of N-hydroxy-1-(2-methoxyethyl)-4-[[4-[[4-(trifluoromethyl)phenyl]amino]phenyl]sulfonyl]-4-piperidinecarboxamide,  
10 monohydrochloride



15

Part A: To a solution of the aniline of part A, Example 395 (2.07 g, 3.82 mmol) in dioxane (9.0 mL) and methanol (3.0 mL) was added a solution of 4N HCl  
20 in dioxane (10 mL, 40 mmol). After stirring at ambient temperature for 2 hours, the reaction mixture was concentrated in vacuo to provide the amine as a yellow solid (1.89 g, >100%).

Part B: To a suspension of the amine of part A (1.83 g, 3.82 mmol) in acetonitrile (20 mL) was added  
25  $K_2CO_3$  (1.58 g, 11.46 mmol) and 2-bromoethyl methyl ether (0.395 mL, 4.20 mmol). After stirring at reflux for 18 hours, the reaction mixture was

filtered through a pad of Celite®, washing with dichloromethane and the filtrate was concentrated in vacuo. Chromatography (on silica, methanol/dichloromethane) provided the methoxy ethyl amine as an off-white solid (1.58 g, 83%).

Part C: To a solution of the methoxy ethyl amine of part B (1.58 g, 3.15 mmol) in tetrahydrofuran (30 mL) was added potassium trimethylsilanolate (0.810 g, 6.31 mmol). The resulting mixture was stirred at ambient temperature for 3 days, and then the solvent was removed by blowing N<sub>2</sub> over the mixture. Water (10 mL) was added and the reaction mixture was neutralized (pH 7) with 1N HCl. The solids were collected by filtration and dried by concentration in vacuo with acetonitrile to provide the amino acid as a pink solid (1.32 g, 86%).

Part D: To a suspension of the amino acid of part C (1.32 g, 2.71 mmol) in N,N-dimethylformamide (12 mL) was added 1-hydroxybenzotriazole (0.439 g, 3.25 mmol), N-methylmorpholine (0.894 mL, 8.13 mmol), O-(tetrahydropuranyl) hydroxylamine (0.476 g, 4.07 mmol) and 1-3-[(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (0.727 g, 3.79 mmol). The resulting mixture was stirred at ambient temperature for 20 hours, then concentrated in vacuo. The residue was partitioned between H<sub>2</sub>O and ethyl acetate. The combined organic layers were washed with H<sub>2</sub>O, saturated NaHCO<sub>3</sub>, saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Chromatography (on silica, methanol/ethyl acetate) provided the protected hydroxamate as an off-white solid (1.39 g, 88%).

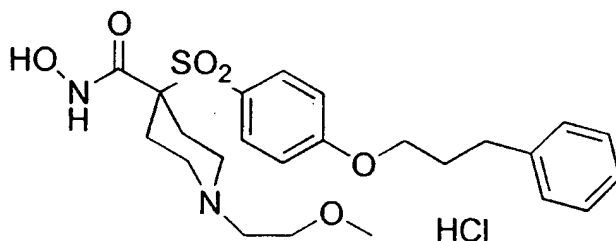
Part E: To a solution of the protected hydroxamate of part D (1.40 g, 2.39 mmol) in dioxane



-615-

(3 mL) and methanol (1 mL) was added a solution of 4N HCl in dioxane (5.98 mL, 23.9 mmol). The resulting mixture was stirred at ambient temperature for 2.5 hours. The reaction mixture was concentrated almost to dryness, by blowing N<sub>2</sub> over the reaction mixture. Diethyl ether (25 mL) was added and the precipitate was collected by filtration. The resulting solid was dissolved in methanol (1 mL) and treated with 4N HCl in dioxane (1.5 mL). After stirring at ambient temperature for 1.5 hours, the reaction mixture was slowly added to diethyl ether (50 mL). The resulting precipitate was collected by filtration to give the title compound as an off-white solid (1.08 g, 84%). MS MH<sup>+</sup> calculated for C<sub>22</sub>H<sub>27</sub>O<sub>5</sub>N<sub>3</sub>SF<sub>3</sub>: 502, found 502.

Example 397: Preparation of ethyl 1-(2-methoxyethyl)-3-phenylpropoxy)phenyl]sulfonyl]-4-piperidinecarboxylate



20

Part A: A mixture of the methoxyethyl amine, ethyl-4-[(4-fluorophenylsulfonyl)]-1-(2-methoxyethyl)-4-piperidinecarboxylate (1.5 g, 4.0 mmol), 3-phenyl-1-propanol (2.2 mL, 16 mmol), and K<sub>2</sub>CO<sub>3</sub> (2.2 g, 16 mmol) in DMAC (6 mL) was heated at 125 degrees Celsius for 1 day and at 135 degrees Celsius for 3 days. After the mixture was

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concentrated in vacuo, diluted with water, and extracted with ethyl acetate. The organic layer was washed with water and brine, dried over magnesium sulfate, and concentrated in vacuo to give a crude oil. The oil was purified by flash chromatography (20:80 hexane/ethyl acetate) to afford the ether as a brown oil (1.35 g, 67%).

Part B: A mixture of the ether of part A (1.3 g, 2.7 mmol) and a 50% NaOH aqueous solution (2.1 g, 27 mmol) in THF (23 mL), EtOH (23 mL), and H<sub>2</sub>O (12 mL) was heated at 60 degrees Celsius under a nitrogen atmosphere for 24 hours. The material was concentrated in vacuo and triturated with diethyl ether to give a solid. The solid was dissolved in water, cooled with an ice bath, acidified with concentrated hydrochloric acid. The precipitate was isolated by filtration, washed with cold water, and dried at ambient temperature in a vacuum oven for 3 days to afford the crude acid.

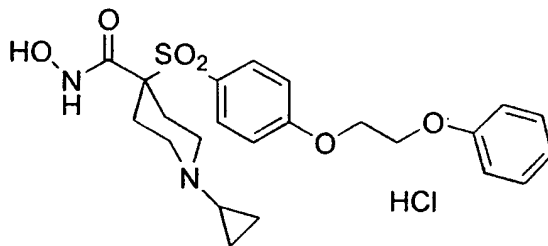
A mixture of the above crude acid (1.1 g), N-hydroxybenzotriazole (0.36 g, 2.7 mmol), 4-methylmorpholine (0.74 mL, 6.7 mmol), 4-(2H-pyran-2-yl-hydroxylamine (0.39 g, 3.3 mmol), 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide (0.60 g, 3.1 mmol) in DMF (11 mL) was stirred at ambient temperature under a nitrogen atmosphere for 18 hours. The mixture was concentrated in vacuo, and dissolved into a solution of saturated NaHCO<sub>3</sub> (90 mL), ethyl acetate (25 mL), and a few drops of 2N NaOH. The aqueous layer was extracted with additional ethyl acetate. The combined ethyl acetate layers were washed with saturated NaHCO<sub>3</sub> solution, water, and brine. After

-617-

drying over magnesium sulfate, the filtrate was concentrated *in vacuo* to give a dark yellow oil. The oil was purified by flash chromatography (40:60 acetonitrile/toluene) to afford the protected  
5 hydroxamate as a yellow oil (0.32 g, 25%): MS MH<sup>+</sup> calcd. for C<sub>29</sub>H<sub>40</sub>N<sub>2</sub>O<sub>7</sub>S 561, found 561.

Part C: To a solution of the protected hydroxamate of part 2B (0.28 g, 0.50 mmol) in methanol (4.0 mL) was added acetyl chloride (0.11 mL,  
10 1.5 mmol) and the solution was stirred at ambient temperature under a nitrogen atmosphere for 2.5 hours. The solution was diluted with diethyl ether and concentrated. The solid was triturated with diethyl ether and dried at 40 degrees Celsius in a  
15 vacuum oven to give the title compound as an off white solid (0.15 g, 20%): MS MH<sup>+</sup> calcd. for C<sub>24</sub>H<sub>32</sub>N<sub>2</sub>O<sub>6</sub>S 477, found 477.

Example 398: Preparation of 1-cyclopropyl-N-hydroxy-  
20 4-[[4-(2-phenoxyethoxy)phenyl]sulfonyl]-  
-4-piperidinecarboxamide,  
monohydrochloride



25 Part A: To a solution of the product of Example 9, part E (14.36 g, 40 mmol) in methanol (50 mL) was added acetic acid (24.5 g, 400 mmol), a portion (about 2 g) of 4-Angstrom molecular sieves,

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(1-ethoxycyclopropyl)-oxytrimethyl silane (25.8 mL, 148 mmol) and sodium cyanoborohydride (7.05 g, 112 mmol). The solution was heated at reflux for 8 hours. The precipitated solids were removed by  
5 filtration and the filtrate was concentrated in vacuo. The residue was diluted with H<sub>2</sub>O (400 mL) and extracted with ethyl acetate. The organic layer was washed with saturated NaCl and dried over MgSO<sub>4</sub>, filtered and concentrated in vacuo. The solid was  
10 filtered, washed with H<sub>2</sub>O/diethyl ether to give the desired cyclopropyl amine {ethyl-4-[(4-fluorophenyl-sulfonyl)]-1-cyclopropyl-4-piperidinecarboxylate} as a white solid (11.83 g, 81.5%). MS MH<sup>+</sup> calculated for C<sub>17</sub>H<sub>22</sub>NO<sub>4</sub>SF: 356, found : 356.

15 Part B: A solution of the cyclopropyl amine of Part A (2.0 g, 5.6 mmol), ethylene glycol phenyl ether (2.8 mL, 23 mmol), and cesium carbonate (7.3 g, 23 mmol) in DMAC (10 mL) was heat at 125-135 degrees Celsius for 18 hours under an atmosphere of nitrogen.  
20 The mixture was concentrated in vacuo, diluted with water, and extracted with ethyl acetate. The combined ethyl acetate layers were washed with water and brine, dried over magnesium sulfate, concentrated in vacuo, dissolved in diethyl ether, precipitated as  
25 the hydrochloride salt, and dried at 40 degrees Celsius in a vacuum oven. The solid was dissolved into a mixture of water, acetonitrile, and ethanol and then the pH was adjusted to 12 with 1N NaOH solution. The mixture was concentrated in vacuo to  
30 remove ethanol and acetonitrile. The solid was isolated by filtration, washed with water, and dried at 50 degrees Celsius in a vacuum oven to afford the ether as a white solid (1.8 g, 68%): MS+ calcd. for

-619-

$C_{25}H_{31}NO_6S$  474, found 474. Anal. calcd. for  $C_{25}H_{31}NO_6S$ :  
C, 63.40; H, 6.60; N, 2.96; S, 6.77. Found: C,  
63.35; H, 6.59; N, 2.99; S, 6.61.

Part C: A mixture of the ether of part B  
5 (1.8 g, 3.7 mmol) and a 50% NaOH aqueous solution  
(3.0 g, 37 mmol) in THF (32 mL), EtOH (32 mL), and  $H_2O$   
(16 mL) was heated at 60 degrees Celsius under a  
nitrogen atmosphere for 24 hours. The material was  
concentrated *in vacuo* and triturated with diethyl  
10 ether to give a solid. The tan solid was dissolved  
into a mixture of water, ethanol, and THF,  
precipitated by adjusting the pH to 3 with  
concentrated hydrochloric acid, concentrated *in*  
*vacuo*, triturated with water, and dried at 50 degrees  
15 Celsius in a vacuum oven to give a crude white solid  
acid (2.3 g).

A mixture of the crude white solid acid  
(2.3 g), N-hydroxybenzotriazole (1.9 g, 14 mmol), 4-  
methylmorpholine (1.6 mL, 14 mmol), O-tetrahydro-2H-  
20 pyran-2-yl-hydroxylamine (1.1 g, 9.4 mmol), and 1-(3-  
dimethylaminopropyl)-3-ethylcarbodiimide  
hydrochloride (2.7 g, 14 mmol) in DMF (90 mL) was  
stirred at ambient temperature under a nitrogen  
atmosphere for 2 days. The mixture was concentrated  
25 *in vacuo*, diluted with water, and extracted with  
ethyl acetate. The organic layer was washed with 1N  
NaOH solution, water, and brine, dried over magnesium  
sulfate, concentrated *in vacuo*, and purification by  
flash chromatography (20:80 to 40:60 ethyl  
30 acetate/toluene) to afford the protected hydroxamate  
as a white solid: (0.43 g, 21%): MS  $MH^+$  calcd. for  
 $C_{28}H_{36}N_2O_7S$  545, found 545. Anal. calcd. for

-620-

$C_{28}H_{36}N_2O_7S$ : C, 61.74; H, 6.66; N, 5.14; S, 5.89.

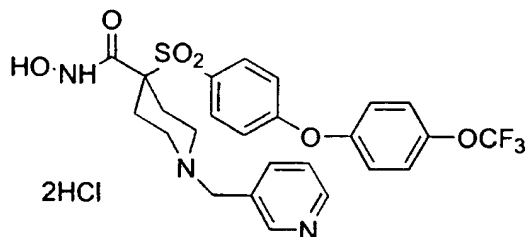
Found: C, 61.72; H, 6.75; N, 5.06; S, 5.91.

Additional compound was isolated by acidifying the aqueous layer to pH of 3, collecting  
5 the solid by filtration, and drying to give a white solid (0.80 g).

Part D: To an ambient temperature solution of acetyl chloride (0.31 mL, 4.4 mmol) in methanol (11 mL) under a nitrogen atmosphere was added the  
10 protected hydroxamate of part C (0.80 g, 1.5 mmol). After stirring for 2.5 hours, the precipitate was collected by filtration, washed with diethyl ether, and dried at 45 degrees Celsius in a vacuum oven to afford the title compound as a white solid (0.58 g,  
15 79%): MS  $MH^+$  calcd. for  $C_{23}H_{28}N_2O_6S$  461, found 461. Anal. calcd. for  $C_{23}H_{28}N_2O_6S \cdot 1.5HCl$ : C, 53.62; H, 5.77; N, 5.44; S, 6.22. Found: C, 53.47; H, 5.79; N, 5.41; S, 6.16.

20 Example 399: Preparation of hydroxy-1-(3-pyridinylmethyl)-4-[[4-[4-(trifluoromethoxy)phenoxy]phenyl]-sulfonyl]-4-piperidinecarboxamide, dihydrochloride

25



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## Part A: A solution of the amine

hydrochloride salt of the product of Example 410 (2.4 g, 4.6 mmol), 3-picolyl chloride (1.5 g, 8.8 mmol), and potassium carbonate (4.3 g, 31 mmol) in DMF (12) 5 was heated at 50 degrees Celsius for 1 day under an atmosphere of nitrogen. The mixture was concentrated in vacuo, dissolved into water, and extracted with ethyl acetate. The organic layers were washed with water and brine, dried over magnesium sulfate, 10 concentrated in vacuo. The residue was purified by flash chromatography (50:50 ethyl acetate/hexane) to afford the 3-picolyl amine as an amber oil (1.6 g, 60%): MS MH<sup>+</sup> calcd. for C<sub>27</sub>H<sub>27</sub>N<sub>2</sub>O<sub>6</sub>SF<sub>3</sub> 565, found 565. Anal. calcd. for C<sub>27</sub>H<sub>27</sub>N<sub>2</sub>O<sub>6</sub>SF<sub>3</sub>: C, 57.44; H, 4.82; N, 15 4.96; S, 5.68. Found: C, 57.49; H, 5.10; N, 4.69; S, 5.67

Part B: A mixture of the 3-picolyl amine of part 4A (1.5 g, 2.6 mmol) and a 50% NaOH aqueous solution (2.1 g, 26 mmol) in THF (22 mL), EtOH (22 20 mL), and H<sub>2</sub>O (11 mL) was heated at 65 degrees Celsius under a nitrogen atmosphere for 24 hours. The material was concentrated in vacuo and triturated with diethyl ether to give a solid. The tan solid was dissolved into water and the pH was adjusted to 1 25 with concentrated hydrochloric acid. The mixture was concentrated in vacuo, and dried in a 45 degrees Celsius vacuum oven to afford the crude white solid acid (2.5 g): MS MH<sup>+</sup> calcd. for C<sub>25</sub>H<sub>23</sub>N<sub>2</sub>O<sub>6</sub>SF<sub>3</sub> 537, found 537.

30 Part C: A mixture of the crude white acid of part B (2.5 g), N-hydroxybenzotriazole (1.0 g, 7.7 mmol), 4-methylmorpholine (0.64 mL, 7.7 mmol), O-tetrahydro-2H-pyran-2-yl-hydroxylamine (0.60 g, 5.1

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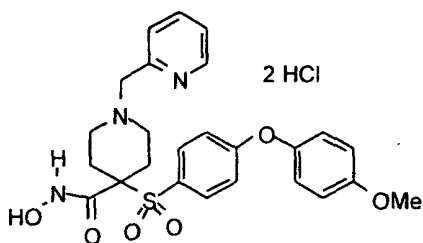
mmol), and 1-(3-dimethyl-aminopropyl)-3-ethylcarbodiimide hydrochloride (1.5 g, 7.7 mmol) in DMF (40 mL) was stirred at ambient temperature under a nitrogen atmosphere for 5 days. The mixture was concentrated in vacuo, diluted with ethyl acetate, and washed with water and brine. The organic layer was dried over magnesium sulfate, concentrated in vacuo, and purified by flash chromatography (5:95 methanol/chloroform) to afford the protected hydroxamate as a white foam (1.1 g, 66%): MS MH<sup>+</sup> calcd. for C<sub>30</sub>H<sub>32</sub>N<sub>3</sub>O<sub>7</sub>SF<sub>3</sub> 636, found 636.

Part D: An ambient temperature solution of the protected hydroxamate of part C (1.0 g, 1.6 mmol) and acetyl chloride (0.34 mL, 4.7 mmol) in methanol (11 mL) under a nitrogen atmosphere was stirring for 2.5 hours, and then poured into diethyl ether. The solid was isolated by filtration and dried at 46 degrees Celsius in a vacuum oven to afford the title compound as a white solid (0.85 g, 87%): Anal. calcd. for C<sub>25</sub>H<sub>24</sub>N<sub>3</sub>O<sub>6</sub>SF<sub>3</sub>·2.2HCl: C, 47.53; H, 4.18; N, 6.65; S, 5.08. Found: C, 47.27; H, 4.34; N, 6.60; S, 5.29. MS MH<sup>+</sup> calcd. for C<sub>25</sub>H<sub>24</sub>N<sub>3</sub>O<sub>6</sub>SF<sub>3</sub> 552, found 552.

Example 400: Preparation of N-Hydroxy-4-[4-(4-methoxyphenoxy)phenyl]sulfonyl]-1-(2-pyridinylmethyl)-4-piperidine-carboxamide, dihydrochloride



-623-



Part A: Ethyl-4-[(4-fluorophenylsulfonyl)]-4-piperidinecarboxylate hydrochloride (2.02 g, 5.76 mmol) was combined with powdered potassium carbonate (2.48 g, 18 mmol) and N,N-dimethylformamide (12 mL). 2-Picolyl hydrochloride (1.0 g, 6.1 mmol) was added, and the mixture was stirred for twenty-four hours at forty degrees Celsius. The reaction mixture was diluted with water (80 mL) and extracted with ethyl acetate (3 X 50mL). The combined organic layers were dried over magnesium sulfate, concentrated, and subjected to chromatography (ethyl acetate) affording the desired pyridine ester as an oil (2.30 g, quantitative).

Part B: The pyridine ethyl ester from Part A (2.30 g, 5.76 mmol) was combined with powdered potassium carbonate (1.29 g, 9 mmol), 4-methoxyphenol (1.12 g, 9.0 mmol), and N,N-dimethylformamide (3 mL), and the mixture was heated at seventy five to eighty degrees C for twenty-four hours. Additional 4-methoxyphenol (300 mg) and potassium carbonate (350 mg) were added, and the mixture was stirred an additional three hours at ninety degrees Celsius. The mixture was diluted with water (50 mL) and extracted with ethyl acetate (3 X 50 mL). The combined organic layers were dried using magnesium

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sulfate, concentrated, and chromatographed, affording the desired ester as an oil (2.85 g, quantitative).

Part C: The ester of part B (2.85 g) was combined with ethanol (18 mL), water (6 mL), and potassium hydroxide (2.24 g, 40 mmol). The mixture was brought to reflux and heated for four and one-half hours. It was cooled to zero degrees Celsius and acidified using concentrated aqueous hydrogen chloride. The solvent was removed, and the resulting solids were dried by azeotroping with acetonitrile. Vacuum was applied until constant weight was achieved.

The crude acid hydrochloride was stirred with N-methylmorpholine (1 mL), 1-hydroxybenzotriazole (0.945 g, 7 mmol), O-tetrahydropyranyl hydroxylamine (0.82 g, 7 mmol), and N,N-dimethylformamide (21 mL). After ten minutes, 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride (1.34 g, 7 mmol) was added, and the mixture was stirred overnight. The reaction was then diluted with half-saturated aqueous sodium bicarbonate (100 mL), and extracted with ethyl acetate (200 mL, then 50 mL). The combined organic layers were dried over magnesium sulfate, concentrated, and chromatographed (9:1 ethyl acetate: hexane) to afford the desired O-tetrahydropyranyl-protected hydroxamate as a yellow oil (2.82 g, 88%).

Part D: The O-tetrahydropyranyl-protected hydroxamate of part C (2.82 g, 5 mmol) was diluted with methanol (20 mL). Acetyl chloride (2.1 mL, 30 mmol) was added over two minutes. The reaction was stirred for 4 hours at ambient temperature, then concentrated to afford 2.59 g of crude

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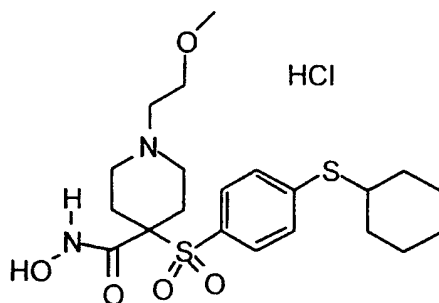
dihydrochloridesalt, which was recrystallized from ethanol/water, affording 525 mg (18%) of the title hydroxamate in the first crop. MS (EI)  $MH^+$  calculated for  $C_{25}H_{27}N_3O_6S$ : 498, found 498.

5

Example 401: Preparation of N-Hydroxy-4-[4-(4-cyclohexylthio)phenyl]sulfonyl]-1-(2-methoxyethyl)-4-piperidine-carboxamide, hydrochloride

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10



Part A: Ethyl-4-[(4-fluorophenylsulfonyl)]-1-(2-methoxyethyl)-4-piperidinecarboxylate (5.5 g, 14 mmol) was combined with powdered potassium carbonate (2.76 g, 20 mmol), N, N-dimethylformamide (7 mL), and cyclohexyl mercaptan (2.4 mL, 20 mmol) and was stirred at ambient temperature for two days. The temperature was raised to forty-five to fifty degrees Celsius and stirring was continued another 24 hours. Additional quantities of potassium carbonate (1.0 g) and cyclohexyl mercaptan (1.0 mL) were introduced and the reaction was heated sixteen additional hours. The mixture was diluted with water (50 mL), and extracted with ethyl acetate (100 mL, then 25 mL). The combined organic layers were dried, concentrated,

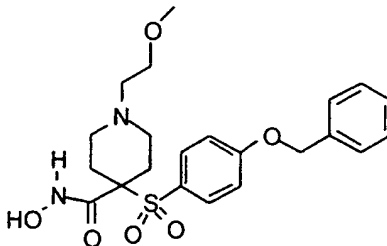
-626-

and chromatographed (ethyl acetate) affording the desired sulfide as a yellow oil (3.59 mL, 53%).

Part B: The sulfide from Part A (3.59 gm, 7.4 mmol) was converted to tetrahydropyranyl-protected hydroxamate by saponification followed by 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride coupling by the method of Example 401, part C, affording 2.16 g (54%) of the desired tetrahydropyranyl-protected hydroxamate as an oil.

Part C: The tetrahydropyranyl-protected hydroxamate from part B (2.16 g, 4 mmol) was diluted with methanol (16 mL). Acetyl chloride (1.1 mL, 16 mmol) was added over one minute. The reaction was stirred for four hours, then concentrated and azeotroped with acetonitrile to afford 1.11 g of crude product, which was recrystallized from absolute ethanol to afford in the first crop 804 mg of the title compound (41%). MS (EI)  $MH^+$  calculated for  $C_{21}H_{32}N_2O_5S_2$ : 457, found 457.

Example 402: Preparation of N-Hydroxyl-1-(2-methoxyethyl)-4-[[ (phenylmethoxy) phenyl]-sulfonyl]-4-piperidinecarboxamide



-627-

Part A: Ethyl-4-[(4-fluorophenylsulfonyl)]-1-(2-methoxyethyl)-4-piperidinecarboxylate (1.58 g, 4.5 mmol) was combined with powdered potassium carbonate (2.42 g, 18 mmol), N,N-dimethylacetamide (5 mL), and benzyl alcohol (1.94 mL, 18 mmol) and was stirred at one hundred forty degrees Celsius for sixteen hours. The mixture was diluted with water (50 mL), and extracted with ethyl acetate (125 mL, then 25 mL). The combined organic layers were dried, concentrated, and chromatographed (ethyl acetate) affording the desired ethyl ester as an oil (1.16 mL, 56%).

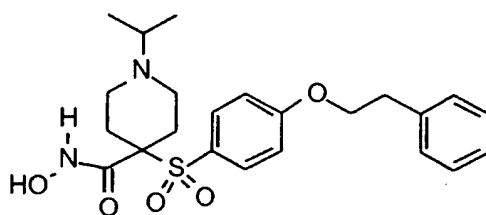
Part B : The ethyl ester from part A (1.16 gm, 2.5 mmol) was converted to the tetrahydropyranyl-protected hydroxamate by saponification followed by 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride coupling by the method of Example 401, part C, affording 880 mg (80%) of the tetrahydropyranyl-protected hydroxamate as an oil.

Part C: The tetrahydropyranyl-protected hydroxamate from Part B (880 mg, 2.0 mmol) was diluted with methanol (8 mL). Acetyl chloride (0.68 mL, 10 mmol) was added over one minute. The reaction was stirred for three hours, then concentrated and azeotroped with acetonitrile to afford the crude product, which was converted to free base by adding enough saturated aqueous sodium bicarbonate (25 mL) to neutralize the hydrogen chloride, then extracting with ethyl acetate (100 mL, then 50 mL). The organic phase was dried with magnesium sulfate, concentrated, and chromatographed (9:1 dichloromethane:methanol, 1% ammonium hydroxide), affording the title hydroxamate

-628-

as a glass, (327 mg, 36%). MS (EI)  $MH^+$  calculated for  $C_{22}H_{28}N_2O_6S$ : 447, found 447.

Example 403: Preparation of N-hydroxyl-1-(1-methylethyl)-4-[[4-(2-phenylethoxy)-phenyl]sulfonyl]-4-piperidine  
carboxamide



10

Part A: Ethyl-4-[(4-fluorophenylsulfonyl)]-1-(1-methylethyl)-4-piperidinecarboxylate (2.75 g, 7.7 mmol) was combined with powdered potassium carbonate (2.62 g, 19 mmol), N, N-dimethylformamide (10 mL), and 2-phenylethanol (2. mL, 19 mmol) and was stirred at eighty-five degrees Celsius for twenty four hours. Additional potassium carbonate (1.3 g) and 2-phenylethanol were added, and the temperature was raised to one hundred-ten degrees Celsius for forty-eight hours, then one hundred thirty-five degrees Celsius for four hours. The mixture was diluted with water (100 mL), and extracted with ethyl acetate (200 mL, then 25 mL). The combined organic layers were dried, concentrated, and chromatographed (ethyl acetate) affording the desired ethyl ester as an oil (3.19 mL, 90%).

Part B: The ethyl ester from Part A (3.19 gm, 6.9 mmol) was converted to tetrahydropyranyl-protected hydroxamate by saponification followed by

-629-

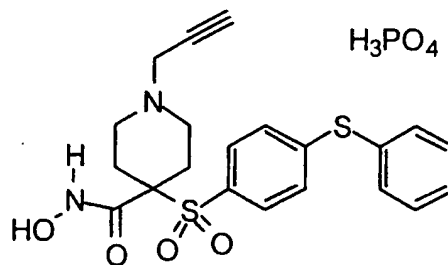
1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride coupling by the method of Example 401, part C, affording 2.27 g (64%) of the title compound as an oil.

5                   Part C: The tetrahydropyranyl-protected hydroxamate from Part B (2.27 mg, 4.4 mmol) was diluted with methanol (16 mL). Acetyl chloride (0.68 mL, 10 mmol) was added over one minute. The reaction was stirred for three hours, then concentrated and  
10 azeotroped with acetonitrile to afford the crude product, which was converted to free base by adding enough saturated sodium bicarbonate (25 mL) to neutralize the hydrogen chloride, then extracting with ethyl acetate (100, then 50 mL). The organic  
15 phase was dried with magnesium sulfate, concentrated, and chromatographed (9:1 dichloromethane:methanol, 1% ammonium hydroxide), affording the desired hydroxamate as a glass, (819 mg, 42%). MS (EI)  $MH^+$  calculated for  $C_{23}H_{30}N_2O_5S$ : 449, found 449.

20

Example 404: Preparation of N-hydroxy-4-[(4-phenylthiophenyl)sulfonyl]-1-(2-propynyl)-4-piperidinecarboxamide, phosphoric acid salt

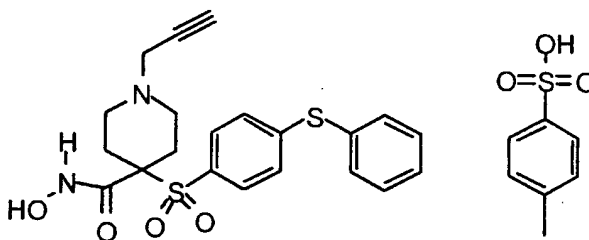
25



N-Hydroxy-4-[(4-phenylthiophenyl)sulfonyl]-  
1-(2-propynyl)-4-piperidinecarboxamide (430 mg, 1.0  
mmol) was dissolved in methanol (15 mL).

Concentrated phosphoric acid (67  $\mu$ L) was added, and  
5 the solution was then concentrated in vacuo. The  
residue was recrystallized from methanol, isolated by  
filtration, and then recrystallized a second time  
from methanol/methyl t-butyl ether affording the  
title phosphate as a solid (215 mg, 41%). Analytical  
10 calculation for  $C_{21}H_{22}N_2O_4 \cdot H_3PO_4$ : C, 47.72; H, 4.77; N,  
5.30, found: C, 47.63; H, 5.04; N, 4.82.

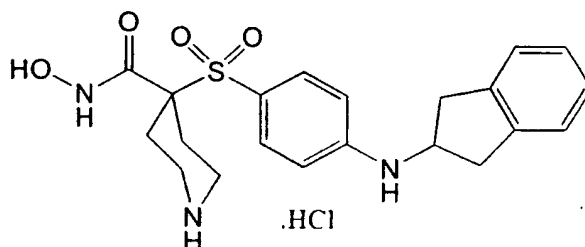
Example 405: Preparation of N-hydroxy-4-[(4-  
phenylthiophenyl)sulfonyl]-1-  
15 (2-propynyl)-4-piperidinecarboxamide,  
p-toluenesulfonic acid salt



20 N-Hydroxy-4-[(4-phenylthiophenyl)sulfonyl]-  
1-(2-propynyl)-4-piperidinecarboxamide (516 mg, 1.0  
mmol) was combined with p-toluenesulfonic acid,  
monohydrate (200 mg, 1.05 mmol), and the mixture was  
dissolved in methanol (3 mL). After four hours, the  
25 resulting white precipitate was collected by  
filtration affording 488 mg (81%) of the title  
tosylate salt, which was characterized  
spectroscopically.



Example 406: Preparation of 4-[[4-[(2,3-dihydro-1H-inden-2-yl)amino]phenyl]sulfonyl]-N-hydroxy-4-piperidinecarboxamide, monohydrochloride



Part A: A solution of the product of Example 9, Part D (0.979 g, 2.36 mmol), 2-aminoindan hydrochloride (1.00 g, 5.89 mmol), and cesium carbonate (1.92 g, 5.89 mmol) in N,N-dimethylformamide (8 mL) was heated to 95 degrees Celsius for 22 hours. The reaction was then cooled, diluted with ethyl acetate (50 mL), and washed with three times with water and once with brine, then dried over sodium sulfate. Concentration gave a residue that was chromatographed on silica gel. Elution with ethyl acetate/hexane (30/70) afforded the desired 4-aminosulfone derivative (450 mg, 36%). MS (EI)  $MH^+$  calculated for  $C_{28}H_{36}N_2O_6S$ : 529, found 529. HRMS  $M^+$  calculated for  $C_{28}H_{36}N_2O_6S$ : 528.2294, found 528.2306.

Part B: To a solution of the ethyl ester of part A (450 mg, 0.85 mmol) in ethanol (3 mL), water (2 mL) and tetrahydrofuran (3 mL) was added sodium hydroxide (340 mg, 8.5 mmol), and the solution was heated to 60 degrees Celsius for 26 hours. The

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solution was cooled and then diluted with water (10 mL) followed by 10% aqueous hydrochloric acid (3 mL) to bring the pH to 2. The resulting solution was extracted with ethyl acetate. The organic extracts were combined and washed with water and brine and dried over sodium sulfate to afford the desired carboxylic acid as a pale brown foam (376 mg, 88%). Analytical calculation for  $C_{26}H_{32}N_2O_6S$ : C, 62.38; H, 6.44; N, 5.60; S, 6.40. Found: C, 62.48; H, 6.69; N, 5.42; S, 6.27.

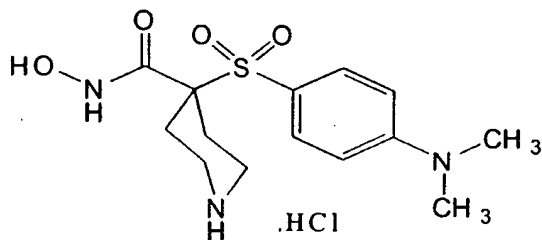
Part C: To a solution of the carboxylic acid of part B (305 mg, 0.609 mmol) in N,N-dimethylformamide (2 mL) was added 4-methylmorpholine (247 mg, 2.44 mmol), N-hydroxybenzotriazole (99 mg, 0.73 mmol), and 1-[3-(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (152 mg, 0.79 mmol) followed by O-(tetrahydro-2H-pyran-2-yl)hydroxylamine (97 mg, 0.82 mmol). After stirring for 2 days at ambient temperature, the solution was concentrated to an oil. Water was added and the mixture was extracted with ethyl acetate. The organic extracts were washed with water and brine and dried over sodium sulfate. Concentration gave a brown foam that was chromatographed on silica gel. Elution with ethyl acetate/hexane (40/60) afforded the protected hydroxamate derivative as a colorless glass (0.38 g, 100%). MS  $MH^+$  calculated for  $C_{31}H_{41}N_3O_7S$ : 600, found 600.

Part D: To a solution of the protected hydroxamate of part C (350 mg, 0.584 mmol) in methanol (3 mL) and 1,4-dioxane (1.5 mL) was added 4 N HCl/1,4-dioxane (1.5 mL, 6 mmol), and the solution was stirred at ambient temperature for 3 hours.

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Concentration gave a residue that was triturated with diethyl ether to afford the title compound as a solid, which was filtered and dried for 40 hours at 51 degrees Celsius (249 mg, 94%). HRMS (ESI)  $MH^+$  calculated for  $C_{21}H_{25}N_3O_4S$ : 416.1644, found 416.1647.

Example 407: Preparation of 4-[[4-(dimethylamino)-phenyl]sulfonyl]-N-hydroxy-4-piperidine-carboxamide, monohydrochloride



Part A: A solution of the product of Example 9, Part D (0.979 g, 2.36 mmol), 2-aminoindan hydrochloride (1.00 g, 5.89 mmol), and cesium carbonate (1.92 g, 5.89 mmol) in N,N-dimethylformamide (8 mL) was heated to 95 degrees Celsius for 22 hours. The reaction was then cooled, diluted with ethyl acetate (50 mL), and washed with three times with water and once with brine, then dried over sodium sulfate. Concentration gave a residue that was chromatographed on silica gel. Elution with ethyl acetate/hexane (30/70) afforded the 4-N,N-dimethylaminosulfone derivative (590 mg, 57%) alongside the product of example 406. MS (EI)  $MH^+$  calculated for  $C_{21}H_{32}N_2O_6S$ : 441, found 441. HRMS calculated for  $C_{21}H_{32}N_2O_6S$ : 440.1981, found 440.1978.

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Part B: To a solution of the ethyl ester of part A (580 mg, 1.3 mmol) in ethanol (4 mL), water (3 mL) and tetrahydrofuran (4 mL) was added sodium hydroxide (520 mg, 13 mmol), and the solution was heated to 62 degrees Celsius for 5 hours. The solution was cooled and then diluted with water (5 mL) followed by 10% aqueous hydrochloric acid (5 mL) to acidify to pH=2. The resulting solution was extracted with ethyl acetate. The organic extracts were combined and washed with water and brine and dried over sodium sulfate to afford the desired carboxylic acid as a pale brown foam (520 mg, 97%). MS  $MH^+$  calculated for  $C_{19}H_{28}N_2O_6S$ : 413, found 413.

Part C: To a solution of the carboxylic acid of part B (500 mg, 1.21 mmol) in N,N-dimethylformamide (4 mL) was added 4-methylmorpholine (490 mg, 4.8 mmol), and 1-[3-(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (302 mg, 1.57 mmol) followed by O-(tetrahydro-2H-pyran-2-yl)hydroxylamine (192 mg, 1.63 mmol). After stirring for 2 days at ambient temperature, the solution was concentrated to an oil. Water (25 mL) was added and the mixture was extracted with ethyl acetate. The organic extracts were washed with water and brine and dried over sodium sulfate. Concentration gave a brown oil, which crystallized from a mixture of ethyl acetate, hexane and methylene chloride (1:1:2) to afford the protected hydroxamate derivative as a colorless solid (506 mg, 82%). MS  $MH^+$  calculated for  $C_{24}H_{37}N_3O_7S$ : 512, found 512.

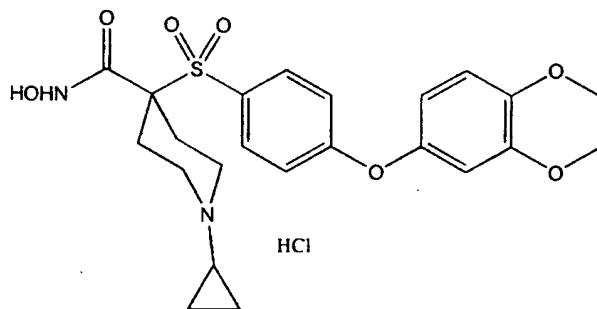
Part D: To a solution of the protected hydroxamate of part C (477 mg, 0.932 mmol) in

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methanol (3 mL) and 1,4-dioxane (3 mL) was added 4 N HCl/1,4-dioxane (2.3 mL, 9.3 mmol), and the solution was stirred at ambient temperature for 3 hours. Concentration gave a residue that was triturated with diethyl ether to afford the title compound as a solid, which was filtered and dried for 40 hours at 51 degrees Celsius (372 mg, 100%). HRMS (ESI)  $MH^+$  calculated for  $C_{14}H_{21}N_3O_4S$ : 328.1331, found 328.1343.

- 10 Example 408: Preparation of 1-cyclopropyl-4-[[[4-  
[(2,3-dihydro-1,4-benzodioxin-6-yl)oxy]  
phenyl]-sulfonyl]-N-hydroxy-4-  
piperidine-carboxamide,  
monohydrochloride

15



- Part A: To a solution of the product of Example 398, Part A (1.36 g, 3.47 mol) in N,N-  
20 dimethylformamide (8 mL) was added 6-hydroxybenzo-  
1,4-dioxane (792 mg, 5.21 mmol) followed by cesium  
carbonate (2.83 g, 8.69 mmol) and the solution was  
heated at one hundred degrees Celsius for 20 hours.  
The solution was partitioned between ethyl acetate  
25 and  $H_2O$ . The aqueous layer was extracted with ethyl  
acetate and the combined organic layers were washed  
with  $H_2O$  and saturated NaCl and dried over  $Na_2SO_4$ .

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Filtration through a silica pad (ethyl acetate/hexane) provided the phenoxyphenyl compound as an orange oil (1.81 g, quantitative yield). MS(CI)  $MH^+$  calculated for  $C_{23}H_{25}NO_7S$ : 488, found 488.

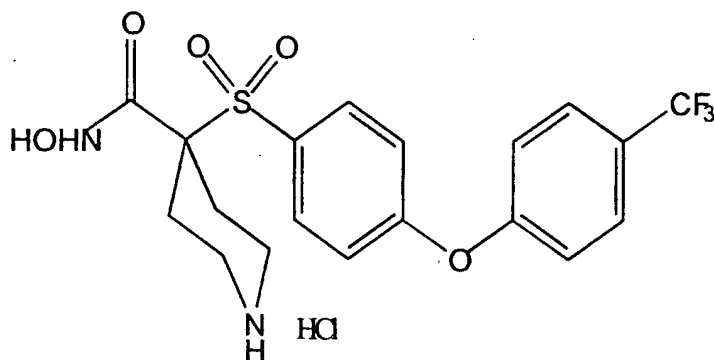
5 Part B: To a solution of the phenoxyphenol compound of part A (1.81 g, <3.47 mmol) in tetrahydrofuran (10 mL) and ethanol (10 mL) sodium hydroxide (1.39 g, 34.7 mmol) in  $H_2O$  (5 mL). The solution was heated to sixty degrees Celsius for 10 20 hours. The solution was concentrated in vacuo and the aqueous residue was acidified to pH = 2 with 10% HCl. The resulting solid was collected by vacuum filtration to provide the acid as a yellow solid (1.23 g, 72%). MS(CI)  $MH^+$  calculated for  $C_{23}H_{25}NO_7S$ : 15 460, found 460. HRMS calculated for  $C_{23}H_{25}NO_7S$ : 460.1430, found 460.1445.

Part C: To a suspension of the acid of part B (1.21 g, 2.46 mmol) in N,N-dimethylformamide (20 mL) was added N-hydroxybenzotriazole (399 mg, 2.95 mmol), 20 4-methylmorpholine (0.81 mL, 7.38 mmol) and O-(tetrahydro-2H-pyran-2-yl)hydroxylamine (432 mg, 3.69 mmol). After stirring for one hour 1-[3-(dimethylamino)propyl]-3-ethylcarbodiimide (660 mg, 3.44 mmol) was added and the 25 solution was stirred for 20 hours at ambient temperature. The solution was partitioned between ethyl acetate and  $H_2O$  and the aqueous layer was extracted with ethyl acetate. The organic layer was washed with saturated NaCl and dried over  $Na_2SO_4$ . 30 Chromatography (on silica, ethyl acetate/hexane) provided the protected hydroxamate as a yellow oil (940 mg, 70 %). MS(CI)  $MH^+$  calculated for  $C_{28}H_{34}N_2O_2S$ : 559, found 559.

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Part D: To a solution of the protected hydroxamate of part C (920 mg, 1.68 mmol) in 1,4-dioxane (15 mL) was added 4N HCl in 1,4-dioxane (10 mL). After stirring at ambient temperature for 2 hours the resulting precipitate was collected by vacuum filtration and washed with ethyl ether to provided the title compound as a white solid (510 mg, 60 %). MS(CI)  $MH^+$  calculated for  $C_{23}H_{26}N_2O_7S$ : 475, found 475. HRMS calculated for  $C_{23}H_{26}NO_7S$ : 475.1539, found 475.1553. Analytical calculation for  $C_{23}H_{26}N_2O_7S \cdot 1.15HCl \cdot 0.5H_2O$ : C, 52.57; H, 5.40; N, 5.33; Cl, 7.76. Found: C, 52.62; H, 5.42; N, 5.79; Cl, 7.71.

Example 409: Preparation of N-hydroxy-4-[[4-[4-(trifluoromethyl)phenoxy]phenyl]sulfonyl]-4-piperidinecarboxamide, monohydrochloride



20

Part A: To a solution of the product of Example 9, Part D (1.5 g, 3.61 mmol) in N,N-dimethylformamide (10 mL) was added cesium carbonate (2.94 g, 9.03 mmol) and  $\alpha,\alpha,\alpha$ -trifluoro-p-cresol (877 mg, 5.41 mmol). The solution was heated to ninety degrees Celsius for 20 hours. The solution was

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partitioned between ethyl acetate and H<sub>2</sub>O and the organic layer was washed with saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Filtration through a silica pad (ethyl acetate) provided the diaryl ether as a yellow  
5 oil (2.30 g, quantitative yield). MS(CI) MH<sup>+</sup> calculated for C<sub>26</sub>H<sub>30</sub>NO<sub>7</sub>SF<sub>3</sub>: 558, found 558.

Part B: To a solution of the diaryl ether of part A (2.30 g, <3.61 mmol) in tetrahydrofuran (10 mL) and ethanol (10 mL) was added sodium hydroxide  
10 (1.44 g, 36.1 mmol) in H<sub>2</sub>O (5 mL) and the solution was heated to sixty degrees Celsius for 18 hours. The solution was concentrated and the aqueous residue was acidified to pH = 2 with 10% HCl and extracted with ethyl acetate. The organic layer was washed with  
15 saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Concentration *in vacuo* provided the acid as a solid (2.11 g, quantitative yield). MS(CI) MH<sup>+</sup> calculated for C<sub>24</sub>H<sub>26</sub>NO<sub>7</sub>SF<sub>3</sub>: 530, found 530.

Part C: To a solution of the acid of part  
20 B (2.11 g, <3.61 mmol) in N,N-dimethylformamide (10 mL) was added N-hydroxybenzotriazole (586 mg, 4.33 mmol), 4-methylmorpholine (1.19 mL, 10.83 mmol) and O-(tetrahydro-2H-pyran-2-yl)hydroxylamine (634 mg, 5.41 mmol). After stirring for one hour, 1-[3-  
25 (dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (969 mg, 5.05 mmol) was added and the solution was stirred for 18 hours. The solution was partitioned between ethyl acetate and H<sub>2</sub>O. The aqueous layer was extracted with ethyl acetate and  
30 the combined organic layers were washed with H<sub>2</sub>O and saturated NaCl and dried over MgSO<sub>4</sub>. Chromatography (on silica, ethyl acetate/hexane) provided the protected hydroxamate as a clear, colorless oil (1.40

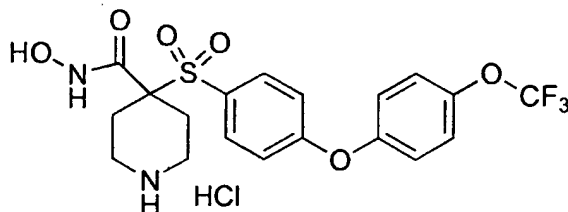


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g, 62 %). MS(CI)  $MH^+$  calculated for  $C_{29}H_{35}N_2O_8SF_3$ : 629, found 629.

Part D: To a solution of the protected hydroxamate of part C (1.40 g, 2.23 mmol) in 1,4-dioxane (10 mL) was added 4N HCl in 1,4-dioxane (15 mL) and the solution was stirred for 2 hours. The solution was diluted with ethyl ether and the resulting precipitate was collected by vacuum filtration to provide the title compound as a white solid (747 mg, 70 %). HPLC purity: 97.5 %. MS(CI)  $MH^+$  calculated for  $C_{19}H_{19}N_2O_5SF_3$ : 445, found 445. HRMS calculated for  $C_{19}H_{19}N_2O_5SF_3$ : 445.1045, found 445.1052. Analytical calculation for  $C_{19}H_{19}N_2O_5SF_3 \cdot 0.5H_2O \cdot 1.0HCl$ : C, 46.58; H, 4.32; N, 5.72; S, 6.55; Cl, 7.24. Found: C, 46.58; H, 3.82; N, 5.61; S, 6.96; Cl, 7.37.

Example 410: Preparation of N-hydroxy-4-[[4-  
[(trifluoromethoxy)phenoxy]phenyl]  
sulfonyl]-4-piperidinecarboxamide,  
monohydrochloride



Part A: To a solution of the product of Example 9, Part D (1.5 g, 3.61 mmol) in N,N-dimethylformamide (10 mL) was added cesium carbonate (2.94 g, 9.03 mmol) and 4-(trifluoromethoxy)phenol (0.70 mL, 5.41 mmol). The solution was heated to ninety degrees Celsius for 20 hours. The solution

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was partitioned between ethyl acetate and H<sub>2</sub>O and the organic layer was washed with saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Filtration through a silica pad (ethyl acetate) provided the phenoxyphenol as a yellow oil (2.11 g, quantitative yield). MS(CI) MNa<sup>+</sup> calculated for C<sub>26</sub>H<sub>30</sub>NO<sub>8</sub>SF<sub>3</sub>: 596, found 596.

Part B: To a solution of the phenoxyphenol of part A (2.11 g, <3.61 mmol) in tetrahydrofuran (10 mL) and ethanol (10 mL) was added sodium hydroxide (1.44 g, 36.1 mmol) in H<sub>2</sub>O (5 mL), and the solution was heated to sixty degrees Celsius for 18 hours. The solution was concentrated and the aqueous residue was acidified to pH = 2 with 10% HCl and extracted with ethyl acetate. The organic layer was washed with saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Concentration *in vacuo* provided the acid as a solid (2.2 g, quantitative yield). MS(CI) MH<sup>+</sup> calculated for C<sub>24</sub>H<sub>26</sub>NO<sub>8</sub>SF<sub>3</sub>: 546, found 546.

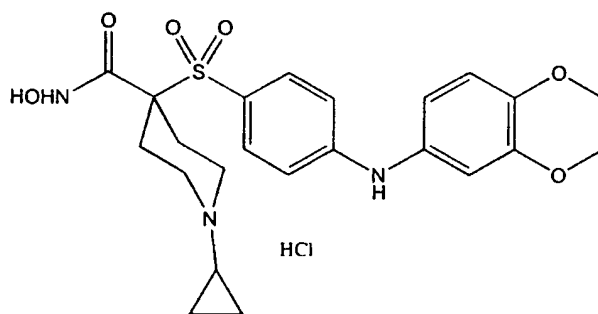
Part C: To a solution of the acid of part B (2.2 g) in N,N-dimethylformamide (10 mL) was added N-hydroxybenzotriazole (586 mg, 4.33 mmol), 4-methylmorpholine (1.19 mL, 10.83 mmol) and O-(tetrahydro-2H-pyran-2-yl)hydroxylamine (634 mg, 5.41 mmol). After stirring for thirty minutes, 1-[3-(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (969 mg, 5.05 mmol) was added and the solution was stirred for 96 hours. The solution was partitioned between ethyl acetate and H<sub>2</sub>O. The aqueous layer was extracted with ethyl acetate and the combined organic layers were washed with H<sub>2</sub>O and saturated NaCl and dried over MgSO<sub>4</sub>. Chromatography (on silica, ethyl acetate/hexane) provided the

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protected hydroxamate as a clear, colorless oil (1.26 g, 53 %).

Part D: To a solution of the protected hydroxamate of part C (1.26 g, 1.96 mmol) in 1,4-dioxane (10 mL) was added 4N HCl in 1,4-dioxane (10 mL) and the solution was stirred for 2 hours. The solution was diluted with ethyl ether and the resulting precipitate was collected by vacuum filtration to provide the title compound as a white solid (455 mg, 47 %). HPLC purity: 98 %. MS(CI)  $MH^+$  calculated for  $C_{19}H_{19}N_2O_6SF_3$ : 461, found 461. HRMS calculated for  $C_{19}H_{19}N_2O_6SF_3$ : 461.0994, found 461.0997. Analytical calculation for  $C_{19}H_{19}N_2O_6SF_3 \cdot 1.0HCl$ : C, 45.93; H, 4.06; N, 5.64; S, 6.45; Cl, 6.45. Found: C, 46.23; H, 4.07; N, 5.66; S, 6.59; Cl, 7.03.

Example 411: Preparation of 1-cyclopropyl-4-[[4-[(2,3-dihydro-1,4-benzodioxin-6-yl)amino]-phenyl]sulfonyl]-N-hydroxy-4-piperidine-carboxamide, monohydrochloride



Part A: To a solution of ester of part C, Example 91 (1.57 g, 3.40 mmol) in 1,4-dioxane (5 mL) was added 4M HCl in 1,4-dioxane (10 mL). After

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stirring for one hour the resulting precipitate was collected by vacuum filtration to provide the amine hydrochloride salt as a white solid (1.16 g, 86 %).

Part B: To a slurry of the amine hydrochloride salt of part A (1.16 g, 2.91 mmol) in 5 methanol (10 mL) was added acetic acid (1.68 mL, 29.1 mmol) followed by (1-ethoxycyclopropyl)-oxytrimethylsilane (3.51 mL, 17.5 mmol) and sodium 10 cyanoborohydride (823 mg, 13.1 mmol). The solution was heated to reflux for six hours. The solution was filtered and the filtrate was concentrated in vacuo. The residue was dissolved into ethyl acetate and washed with H<sub>2</sub>O, aqueous sodium hydroxide and 15 saturated NaCl and dried over MgSO<sub>4</sub>. Concentration in vacuo provided the N-cyclopropyl compound as a white solid (1.03 g, 88 %).

Part C: To a solution of the N-cyclopropyl compound of part B (1.0 g, 2.49 mmol) in toluene (6 mL) was added cesium carbonate (1.14 g, 3.49 mmol), 20 tris(dibenzylideneacetone)dipalladium(0) (69 mg, 0.075 mmol) R-(+)-2,2'-bis(diphenylphosphino)-1,1'-binaphthyl (69 mg, 0.112 mmol) and 1,4-benzodioxane-6-amine (451 mg, 2.99 mmol) and the solution was heated to one hundred degrees Celsius for 19 hours. 25 The solution was diluted with ethyl ether and filtered through Super Cel®. The filtrate was concentrated and chromatography (on silica, ethyl acetate/hexane) provided the aniline compound as an orange oil (561 mg, 48 %). MS(Cl) MH<sup>+</sup> calculated for 30 C<sub>24</sub>H<sub>28</sub>N<sub>2</sub>O<sub>6</sub>S: 473, found 473.

Part D: To a solution of the aniline compound of part C (550 mg, 1.16 mmol) in tetrahydrofuran (10 mL) was added potassium

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trimethylsilanolate (297 mg, 3.48 mmol) and the solution was stirred for 18 hours at ambient temperature. The solution was concentrated and the resulting residue was suspended in H<sub>2</sub>O. The solid was  
5 collected by vacuum filtration to provide the crude acid (282 mg).

Part E: To a solution of the crude acid of part D (282 mg, 0.62 mmol) in N,N-dimethylformamide (10 mL) was added N-hydroxybenzotriazole (100 mg,  
10 0.74 mmol), 4-methylmorpholine (0.20 mL, 1.86 mmol), and O-(tetrahydro-2H-pyran-2-yl) hydroxylamine (108 mg, 0.93 mmol). After stirring for 30 minutes, 1-[3-(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (166 mg, 0.87 mmol) was added and the  
15 solution was stirred for 72 hours. The solution was partitioned between ethyl acetate and H<sub>2</sub>O and the aqueous layer was extracted with ethyl acetate. The combined organic layers were washed with H<sub>2</sub>O and saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Chromatography  
20 (on silica, ethyl acetate/hexane) provided the protected hydroxamate as a white solid (150 mg, 43 %). MS(CI) MH<sup>+</sup> calculated for C<sub>28</sub>H<sub>35</sub>N<sub>3</sub>O<sub>7</sub>S: 558, found 558.

Part F: To a solution of protected  
25 hydroxamate of part E (133 mg, 0.24 mmol) in 1,4-dioxane (5 mL) was added 4N HCl in 1,4-dioxane (10 mL) and the solution was stirred for 1.5 hours. The solution was diluted with ethyl ether and the resulting precipitate was collected by vacuum  
30 filtration to provide the title hydroxamate as a white solid (80 mg, 66 %). MS(CI) MH<sup>+</sup> calculated for C<sub>23</sub>H<sub>27</sub>N<sub>3</sub>O<sub>6</sub>S: 474, found 474. HRMS calculated for C<sub>23</sub>H<sub>27</sub>N<sub>3</sub>O<sub>6</sub>S: 474.1699, found 474.1715. Analytical

calculation for  $C_{23}H_{27}N_3O_6S \cdot 1.5HCl \cdot 1.5H_2O$ : C, 49.75; H, 5.72; N, 7.57; S, 5.77; Cl, 9.58. Found: C, 49.78; H, 5.52; N, 8.05; S, 9.16; Cl, 5.76.

5    Example 412: Preparation of 1-cyclopropyl-4-{[4-[4-

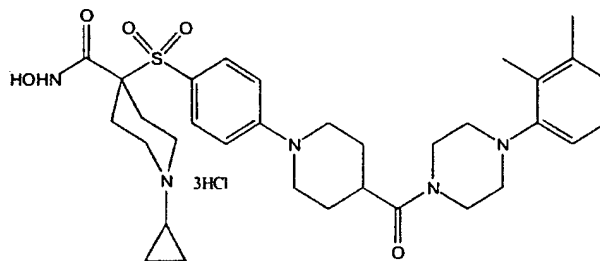
[4-(2,3-dimethylphenyl)-1-

piperazinyl]-carbonyl]-1-

piperidinyl]phenyl}sulfonyl]-

N-hydroxy-4-piperidine-carboxamide,

10                 trihydrochloride



15                   Part A: To a solution of the isonipecotic  
acid (10.5 g, 81.3 mmol) in H<sub>2</sub>O (325 mL) was added  
sodium carbonate (8.37 g, 81.3 mmol) and the solution  
was stirred until homogeneous. To this solution was  
added di-tert-butyl dicarbonate (18.22 g, 83.5 mmol)  
20 in 1,4-dioxane (77 mL) dropwise, and the resulting  
solution was stirred for 72 hours at ambient  
temperature. The solution was concentrated *in vacuo*  
and the resulting aqueous solution was washed with  
ethyl ether. The aqueous solution was acidified to  
25 pH=2 with concentrated HCl. The solution was  
extracted with ethyl ether and concentrated *in vacuo*  
provided a white solid. Recrystallization (ethyl

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acetate) provided N-Boc-isonipecotic acid as a white solid (10 g, 54 %).

Part B: To a solution of the N-Boc-isonipecotic acid of part A (2.14 g, 9.33 mmol) in dichloromethane (19 mL) were added 1-[3-(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (1.82 g, 9.49 mmol), N-hydroxybenzotriazole (1.32 g, 9.77 mmol) and 1-(2,3-xylyl)piperazine monohydrochloride (2.47 g, 10.89 mmol). After 30 minutes diisopropylethylamine (0.74 mL, 20.7 mmol) was added, and the solution was stirred for 18 hours. The solution was concentrated *in vacuo* and the residue was dissolved into ethyl acetate and washed with 1M HCl, saturated NaHCO<sub>3</sub> and saturated NaCl. The solution was dried over MgSO<sub>4</sub>. Recrystallization (ethyl acetate/hexane) provided the amide as an off-white solid (2.65 g, 71 %).

Part C: To a solution of the amide of part B (1.0 g, 3.75 mmol) in dichloromethane (5 mL) was added trifluoroacetic acid (5 mL) and the solution was stirred for 15 minutes. The solution was concentrated *in vacuo* and the resulting oil was dissolved into N,N-dimethylacetamide (10 mL). To this solution was added the product of Example 398, Part A (979 mg, 2.50 mmol) and cesium carbonate (3.67 g, 11.25 mmol) and the solution was heated at one hundred and ten degrees Celsius for 17 hours. The solution was partitioned between ethyl acetate and H<sub>2</sub>O. The organic layer was washed with H<sub>2</sub>O and saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. Concentration *in vacuo* provided the piperidine compound as a white solid (1.89 g, quantitative yield). MS(CI) MH<sup>+</sup> calculated for C<sub>35</sub>H<sub>48</sub>N<sub>4</sub>O<sub>5</sub>S: 637, found 637.

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Part D: To a solution of the piperidine compound of part C (1.89 g) in ethanol (8 mL) and tetrahydrofuran (8 mL) was added sodium hydroxide (1.0 g, 25 mmol) in H<sub>2</sub>O (5 mL). The solution was  
5 heated to fifty degrees Celsius for 8 hours and at sixty-two degrees Celsius for 8 hours. The solution was concentrated in vacuo and the residue was diluted with H<sub>2</sub>O and acidified to pH = 3 with 3M HCl. The resulting precipitate was collected by vacuum  
10 filtration to provide the acid as a white solid (1.16 g, 65 %). MS(CI) MH<sup>+</sup> calculated for C<sub>33</sub>H<sub>44</sub>N<sub>4</sub>O<sub>5</sub>S: 609, found 609.

Part E: To a solution of the acid of part D (1.16 g, 1.62 mmol) in N,N-dimethylformamide (10  
15 mL) were added N-hydroxybenzotriazole (262 mg, 1.94 mmol), 4-methylmorpholine (0.90 mL, 8.2 mmol) and O-(tetrahydro-2H-pyran-2-yl) hydroxylamine (284 mg, 2.4 mmol). After stirring for 45 minutes, 1-[3-(dimethylamino)propyl]-3-ethylcarbodiimide  
20 hydrochloride (334 mg, 2.2 mmol) was added and the solution was stirred for 18 hours at ambient temperature. The solution was partitioned between ethyl acetate and H<sub>2</sub>O and the organic layer was washed with H<sub>2</sub>O and saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>.  
25 Trituration (dichloromethane) provided the protected hydroxamate as a white solid (850 mg, 75 %). MS(CI) MH<sup>+</sup> calculated for C<sub>38</sub>H<sub>53</sub>N<sub>5</sub>O<sub>6</sub>S: 708, found 708.  
Analytical calculation for C<sub>38</sub>H<sub>53</sub>N<sub>5</sub>O<sub>6</sub>S•0.5H<sub>2</sub>O: C, 63.66; H, 7.59; N, 9.77; S, 4.47. Found: C, 63.68; H, 7.54;  
30 N, 9.66; S, 4.67.

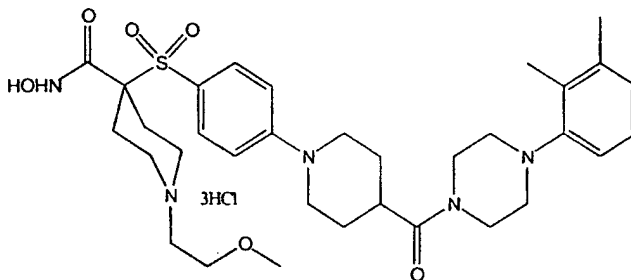
Part F: To a solution of the protected hydroxamate of part E (746 mg, 1.07 mmol) in methanol (10 mL) was added 4M HCl in 1,4-dioxane (10 mL) and



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the solution was stirred for one hour. The resulting solid was collected by vacuum filtration and washed with ethyl ether to provide the title compound as a white solid (650 mg, 83 %). MS(CI)  $MH^+$  calculated for  $C_{33}H_{45}N_5O_5S$ : 624, found 624. HRMS calculated for  $C_{33}H_{49}N_5O_5S$ : 624.3220, found 624.3253. Analytical calculation for  $C_{33}H_{45}N_5O_5S \cdot 3.5HCl \cdot H_2O$ : C, 51.82; H, 6.59; N, 9.16. Found: C, 52.04; H, 6.30; N, 8.96.

- 10 Example 413: Preparation of 4-[[4-[4-[[4-(2,3-dimethylphenyl)-1-piperazinyl]carbonyl]-1-piperidinyl]phenylsulfonyl]-N-hydroxy-1-(2-methoxyethyl)-4-piperidine-carboxamide,  
15 trihydrochloride



- Part A: To a solution of the isonipecotic  
20 acid (10.5 g, 81.3 mmol) in  $H_2O$  (325 mL) was added sodium carbonate (8.37 g, 81.3 mmol) and the solution was stirred until homogeneous. To this solution was added di-tert-butyl dicarbonate (18.22 g, 83.5 mmol) in 1,4-dioxane (77 mL) dropwise and the resulting  
25 solution was stirred for 72 hours at ambient temperature. The solution was concentrated in vacuo and the resulting aqueous solution was washed with

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ethyl ether. The aqueous solution was acidified to pH=2 with concentrated HCl. The solution was extracted with ethyl ether and concentration *in vacuo* provided a white solid. Recrystallization (ethyl acetate) provided N-Boc-isonipecotic acid as a white solid (10 g, 54 %).

Part B: To a solution of the N-Boc-isonipecotic acid of part A (2.14 g, 9.33 mmol) in dichloromethane (19 mL) were added 1-[3-(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (1.82 g, 9.49 mmol), N-hydroxybenzotriazole (1.32 g, 9.77 mmol) and 1-(2,3-xylyl)piperazine monohydrochloride (2.47 g, 10.89 mmol). After 30 minutes, diisopropylethylamine (0.74 mL, 20.7 mmol) was added and the solution was stirred for 18 hours. The solution was concentrated *in vacuo* and the residue was dissolved into ethyl acetate and washed with 1M HCl, saturated NaHCO<sub>3</sub> and saturated NaCl. The solution was dried over MgSO<sub>4</sub>. Recrystallization (ethyl acetate/hexane) provided the amide as an off-white solid (2.65 g, 71 %).

Part C: To a solution of the amide of part B (965 mg, 2.41 mmol) in dichloromethane (5 mL) was added trifluoroacetic acid (5 mL) and the solution was stirred for 15 minutes. The solution was concentrated *in vacuo* and the resulting oil was dissolved into N,N-dimethylacetamide (10 mL). To this solution were added ethyl-4-[(4-fluorophenylsulfonyl)]-1-(2-methoxyethyl)-4-piperidinecarboxylate (600 mg, 1.61 mmol) and cesium carbonate (2.75 g, 8.43 mmol), and the solution was heated at one hundred and ten degrees Celsius for 20 hours. The solution was partitioned between ethyl

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acetate and H<sub>2</sub>O. The organic layer was washed with H<sub>2</sub>O and saturated NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>.

Concentration in vacuo provided the piperidine compound as a white solid (1.26 g, quantitative yield). MS(CI) MH<sup>+</sup> calculated for C<sub>35</sub>H<sub>50</sub>N<sub>4</sub>O<sub>6</sub>S: 655, found 655.

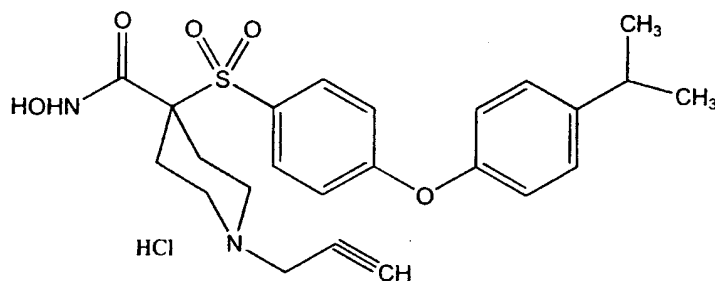
Part D: To a solution of the piperidine compound of part C (1.26 g) in ethanol (5 mL) and tetrahydrofuran (5 mL) was added sodium hydroxide (644 mg, 16 mmol) in H<sub>2</sub>O (5 mL). The solution was heated to sixty degrees Celsius for 8 hours and at sixty-two degrees Celsius for 8 hours. The solution was concentrated in vacuo and the residue was diluted with H<sub>2</sub>O and acidified to pH = 3 with 3M HCl. The resulting precipitate was collected by vacuum filtration to provide the acid as a white solid (650 mg, 65 %). MS(CI) MH<sup>+</sup> calculated for C<sub>33</sub>H<sub>46</sub>N<sub>4</sub>O<sub>6</sub>S: 627, found 627.

Part E: To a solution of the acid of part D (620 g, 0.94 mmol) in N,N-dimethylformamide (10 mL) were added N-hydroxybenzotriazole (152 mg, 1.13 mmol), 4-methylmorpholine (0.52 mL, 4.7 mmol) and O-(tetrahydro-2H-pyran-2-yl) hydroxylamine (165 mg, 1.4 mmol). After stirring for 45 minutes, 1-[3-(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (252 mg, 1.32 mmol) was added and the solution was stirred for 18 hours at ambient temperature. The solution was partitioned between ethyl acetate and H<sub>2</sub>O, and the organic layer was washed with H<sub>2</sub>O and saturated NaCl, and dried over Na<sub>2</sub>SO<sub>4</sub>. Concentration in vacuo provided the protected hydroxamate as a white solid (641 mg, 94 %). MS(CI) MH<sup>+</sup> calculated for C<sub>38</sub>H<sub>55</sub>N<sub>5</sub>O<sub>7</sub>S: 726, found 726.

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Part F: To a solution of the protected hydroxamate of part E (630 mg, 0.87 mmol) in methanol (8 mL) was added 4M HCl in 1,4-dioxane (10 mL) and the solution was stirred for one hour. The resulting solid was collected by vacuum filtration and washed with ethyl ether to provide the title compound as a white solid (624 mg, 83 %). MS(CI)  $MH^+$  calculated for  $C_{33}H_{47}N_5O_6S$ : 642, found 642.

- 10 Example 414: Preparation of N-hydroxy-4-[[4-[4-(1-methylethyl)phenoxy]phenyl]sulfonyl]-1-(2-propynyl)-4-piperidinecarboxamide, monohydrochloride



Part A: To a solution of the product of Example 9, Part E (6.0 g, 15.4 mmol) and powdered  $K_2CO_3$  (8.0 g, 38.5 mmol) in N,N-dimethylformamide (70 mL) was added 4-isopropyl phenol (5.24 g, 38.5 mmol) at ambient temperature, and the solution was heated to ninety degrees Celsius for 32 hours. The solution was concentrated under high vacuum and the residue was dissolved in ethyl acetate. The organic layer was washed with 1N NaOH,  $H_2O$  and dried over  $MgSO_4$ . Chromatography on silica eluting with ethyl acetate/hexane provided the diaryl ether as light yellow gel (6.89 g, 87%).

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Part B: To a solution of diaryl ether of part A (6.89 g, 14.7 mmol) in ethanol (14 mL) and tetrahydrofuran (14 mL) was added NaOH (5.88 g, 147 mmol) in H<sub>2</sub>O (28 mL) from an addition funnel at ambient temperature. The solution was then heated to sixty degrees Celsius for 17 hours and ambient temperature for 24 hours. The solution was concentrated *in vacuo* and diluted with water. The aqueous layer was extracted with ether and acidified to pH = 2. Vacuum filtration of white precipitation provided the acid as a white solid (6.56 g, quantitative yield).

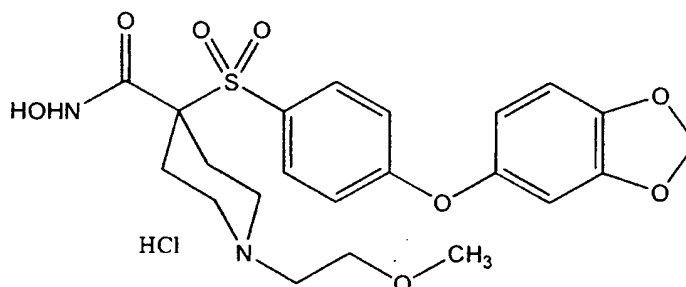
Part C: To the solution of acid of part B (6.56 g, 14.86 mmol), N-methyl morpholine (6.5 mL, 59.4 mmol), 1-hydroxybenzotriazole (6.0 g, 44.6 mmol) and O-tetrahydropyranyl hydroxyl amine (3.5 g, 29.7 mmol) in N,N-dimethylformamide (50 mL) was added 1-[3-(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (8.5 g, 44.6 mmol), and the solution was stirred at ambient temperature for 20 hours. The solution was concentrated under high vacuum and the residue was dissolved in ethyl acetate. The organic layer was washed with saturated aqueous NaHCO<sub>3</sub>, H<sub>2</sub>O and dried over MgSO<sub>4</sub>. Concentration *in vacuo* and chromatography on silica eluting with ethyl acetate/hexane provided the tetrahydropyranyl-protected hydroxamate as a white foam (8.03 g, quantitative yield).

Part D: To a solution of 4N HCl in dioxane (37 mL, 149 mmol) was added a solution of the tetrahydropyranyl-protected hydroxamate of part C (8.03 g, 14.9 mmol) in methanol (5 mL) and dioxane (15 mL) and the solution was stirred at ambient

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temperature for 3 hours. Concentration *in vacuo* and trituration with diethyl ether provided the title compound as a white solid (5.0 g, 71.1%). Analytical calculation for  $C_{24}H_{28}N_2O_5S \cdot HCl \cdot 0.9H_2O$ : C, 56.61; H, 6.10; N, 5.50; S, 6.30. Found: C, 56.97; H, 6.05; N, 5.41; S, 5.98. HRMS  $MH^+$  calculated for  $C_{24}H_{28}N_2O_5S$ : 457.1797, found 457.1816.

Example 415: Preparation of 4-[[4-(1,3-benzodioxol-5-yloxy)phenyl)sulfonyl]-N-hydroxy-1-(2-methoxyethyl)-4-piperidinecarboxamide, monohydrochloride



Part A: To a solution of the product of Example 9, Part D (25 g, 67.3 mmol) and powdered  $K_2CO_3$  (23.3 g, 169 mmol) in N,N-dimethylformamide (150 mL) was added sesamol (23.2 g, 168 mmol) at ambient temperature and solution was heated to ninety degrees Celsius for 25 hours. The solution was concentrated under high vacuum and the residue was dissolved in ethyl acetate. The organic layer was washed with 1N NaOH,  $H_2O$  and dried over  $MgSO_4$ . Chromatography on silica eluting with ethyl acetate/hexane provided the

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desired diaryl ether as light yellow gel (33.6 g, 93.6%).

Part B: To a solution of diaryl ether of part A (4.0 g, 7.4 mmol) in dichloromethane (7 mL) cooled to zero degrees Celsius was added trifluoroacetic acid (7 mL) and the solution was stirred at ambient temperature for 2 hours. Concentration *in vacuo* provided the amine trifluoroacetate salt as a light yellow gel. To the solution of the trifluoroacetate salt and K<sub>2</sub>CO<sub>3</sub> (3.6 g, 26 mmol) in N,N-dimethylformamide (50 mL) was added 2-bromoethyl methyl ether (1.8 mL, 18.7 mmol) and the solution was stirred at ambient temperature for 36 hours. The N,N-dimethylformamide was evaporated under high vacuum and residue was diluted with ethyl acetate. The organic layer was washed with water and dried over Mg<sub>2</sub>SO<sub>4</sub>. Concentration *in vacuo* provided the methoxyethyl amine as a light yellow gel (3.7 g, quantitative yield).

Part C: To a solution of methoxyethyl amine of part B (3.7 g, 7.5 mmol) in ethanol (7 mL) and tetrahydrofuran (7 mL) was added NaOH (3.0 g, 75 mmol) in H<sub>2</sub>O (15 mL) from an addition funnel at ambient temperature. The solution was then heated to sixty degrees Celsius for 19 hours and ambient temperature for 12 hours. The solution was concentrated *in vacuo* and diluted with water. The aqueous layer was extracted with ether and acidified to pH=2. Vacuum filtration of the white precipitate provided the acid as a white solid (4.0 g, quantitative yield).

Part D: To a solution of the acid of part C (4.0 g, 7.5 mmol), N-methyl morpholine (3.3 mL, 30

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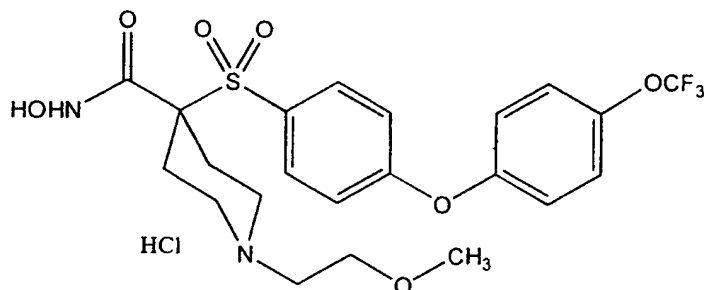
mmol), 1-hydroxybenzotriazole (3.0 g, 22.5 mmol) and O-tetrahydropyranyl hydroxyl amine (1.8 g, 15 mmol) in N,N-dimethylformamide (100 mL) was added 1-[3-(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (4.3 g, 22.5 mmol), and the solution was stirred at ambient temperature for 4 days. The solution was concentrated under high vacuum and the residue was dissolved in ethyl acetate. The organic layer was washed with saturated aqueous NaHCO<sub>3</sub>, H<sub>2</sub>O and dried over Mg<sub>2</sub>SO<sub>4</sub>. Concentration *in vacuo* and chromatography on silica eluting with ethyl acetate/hexane provided the tetrahydropyranyl-protected hydroxamate as a white foam (2.40 g, 57.1%).

Part E: To a solution of 4N HCl in dioxane (11 mL, 43 mmol) was added a solution of the tetrahydropyranyl-protected hydroxamate of part D (2.4 g, 4.3 mmol) in methanol (2 mL) and dioxane (6 mL) and the solution was stirred at ambient temperature for 3 hours. Concentration *in vacuo* and trituration with ether provided hydroxamate hydrochloride salt as a white solid (1.88 g, 85.8%). Analytical calculation for C<sub>22</sub>H<sub>26</sub>N<sub>2</sub>O<sub>8</sub>S.HCl.H<sub>2</sub>O: C, 49.58; H, 5.48; N, 5.26; S, 6.02. Found: C, 49.59; H, 5.53; N, 5.06; S, 5.71. HRMS MH<sup>+</sup> calculated for C<sub>22</sub>H<sub>26</sub>N<sub>2</sub>O<sub>8</sub>S: 479.1488, found 479.1497.

Example 416: Preparation of N-hydroxy-1-(2-methoxyethyl)-4-[[4-[4-(trifluoromethoxy)phenoxy]phenyl]sulfonyl]-4-piperidinecarboxamide,  
monohydrochloride



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Part A: To a solution of the product of Example 9, Part D (30 g, 161 mmol) in dichloromethane (50 mL) cooled to zero degrees Celsius was added  
5 trifluoroacetic acid (25 mL) and the solution was stirred at ambient temperature for 1 hour. Concentration *in vacuo* provided the amine trifluoroacetate salt as a light yellow gel. To the  
10 solution of the trifluoroacetate salt and K<sub>2</sub>CO<sub>3</sub> (3.6 g, 26 mmol) in N,N-dimethylformamide (50 mL) cooled to zero degrees Celsius was added 2-bromoethyl methyl ether (19 mL, 201 mmol), and solution was stirred at ambient temperature for 36 hours. Then, N,N-  
15 dimethylformamide was evaporated under high vacuum and the residue was diluted with ethyl acetate. The organic layer was washed with water and dried over MgSO<sub>4</sub>. Concentration *in vacuo* provided the methoxyethyl amine as a light yellow gel (26.03 g,  
20 86.8%).

Part B: To a solution of methoxyethyl amine (6.0 g, 16.0 mmol) of part A and powdered K<sub>2</sub>CO<sub>3</sub> (4.44 g, 32 mmol) in N,N-dimethylformamide (30 mL) was added 4-  
(trifluoromethoxy)phenol (5.72 g, 32 mmol) at ambient  
25 temperature and the solution was heated to ninety degrees Celsius for 25 hours. The solution was concentrated under high vacuum and the residue was

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dissolved in ethyl acetate. The organic layer was washed with 1N NaOH, H<sub>2</sub>O and dried over MgSO<sub>4</sub>.

Chromatography on silica eluting with ethyl acetate/hexane provided trifluoromethoxy

5 phenoxyphenyl sulfone as a light yellow gel (7.81 g, 91.5%).

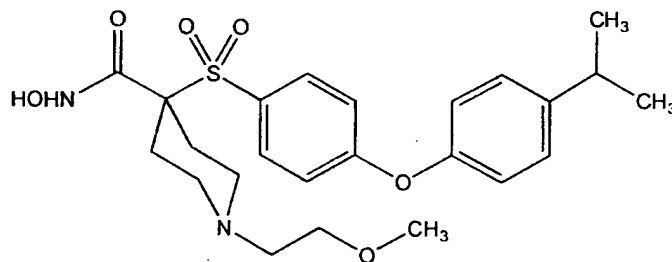
Part C: To a solution of trifluoromethoxy phenoxyphenyl sulfone of part B (7.81 g, 14.7 mmol) in ethanol (14 mL) and tetrahydrofuran (14 mL) was  
10 added NaOH (5.88 g, 147 mmol) in H<sub>2</sub>O (28 mL) from an addition funnel at ambient temperature. The solution was then heated to sixty degrees Celsius for 18 hours. The solution was concentrated *in vacuo* and diluted with water. The aqueous layer was extracted  
15 with ether and acidified to pH=2. Vacuum filtration of white precipitation provided the acid as a white solid (5.64 g, 73.3%).

Part D: To a solution of the acid of part C (5.64 g, 10.8 mmol), N-methyl morpholine (4.8 mL,  
20 43.1 mmol), 1-hydroxybenzotriazole (4.38 g, 32.4 mmol) and O-tetrahydropyranyl hydroxyl amine (2.5 g, 21.6 mmol) in N,N-dimethylformamide (50 mL) was added 1-[3-(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (6.2 g, 32.4 mmol), and the solution  
25 was stirred at ambient temperature for 24 hours. The solution was concentrated under high vacuum and the residue was dissolved in ethyl acetate. The organic layer was washed with saturated aqueous NaHCO<sub>3</sub>, H<sub>2</sub>O and dried over MgSO<sub>4</sub>. Concentration *in vacuo* and  
30 chromatography on silica eluting with ethyl acetate/hexane provided the tetrahydropyranyl-protected hydroxamate as a white foam (6.65 g, quantitative yield).

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Part E: To a solution of 4N HCl in dioxane (28 mL, 110 mmol) was added a solution of the tetrahydropyranyl-protected hydroxamate of part D (6.65 g, 11.03 mmol) in methanol (3 mL) and dioxane (9 mL) and was stirred at ambient temperature for 3 hours. Concentration *in vacuo* and trituration with diethyl ether provided the title compound as a white solid (4.79 g, 78.2%). Analytical calculation for  $C_{22}H_{25}N_2O_7SF_3 \cdot HCl \cdot 0.5H_2O$ : C, 46.85; H, 4.83; N, 4.97; S, 5.69. Found: C, 46.73; H, 4.57; N, 4.82; S, 5.77.

Example 417: Preparation of N-hydroxy-1-(2-methoxyethyl)-4-[[4-[4-(1-methylethyl)-phenoxy]phenyl]sulfonyl]-4-piperidinecarboxamide, monohydrochloride



Part A: To a solution of ethyl-4-[(4-fluorophenylsulfonyl)]-1-(2-methoxyethyl)-4-piperidinecarboxylate (1.47 g, 3.9 mmol) and powdered  $K_2CO_3$  (1.6 g, 11.7 mmol) in N,N-dimethylformamide (15 mL) was added 4-isopropylphenol (1.07 g, 7.8 mmol) at ambient temperature and the solution was heated to ninety degrees Celsius for 24 hours. The solution was concentrated under high vacuum and the residue was dissolved in ethyl acetate. The organic layer was washed with 1N NaOH,  $H_2O$  and dried over  $MgSO_4$ .

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Chromatography on silica eluting with ethyl acetate/hexane provided the diaryl ether as a light yellow gel (1.77 g, 92.2%).

Part B: To a solution of diaryl ether of part A  
5 (1.77 g, 3.6 mmol) in ethanol (3.5 mL) and tetrahydrofuran (3.5 mL) was added NaOH (1.46 g, 36 mmol) in H<sub>2</sub>O (7 mL) at ambient temperature. The solution was then heated to sixty degrees Celsius for 18 hours. The solution was concentrated *in vacuo* and  
10 diluted with water. The aqueous layer was extracted with diethyl ether and acidified to pH=2. Vacuum filtration of the white precipitate provided the acid as a white solid (1.39 g, 83.7%).

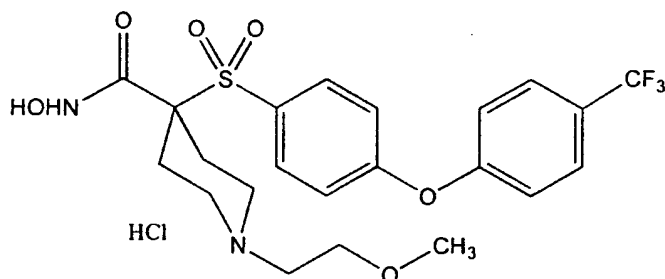
Part C: To the solution of the acid of part B  
15 (1.39 g, 3.0 mmol), N-methyl morpholine (1 mL, 9 mmol), 1-hydroxybenzotriazole (1.22 g, 9 mmol) and O-tetrahydropyranyl hydroxyl amine (0.72 g, 6.0 mmol) in N,N-dimethylformamide (90 mL) was added 1-[3-(dimethylamino)propyl]-3-ethylcarbodiimide  
20 hydrochloride (1.72 g, 9.0 mmol), and solution was stirred at ambient temperature for 48 hours. The solution was concentrated under high vacuum and the residue was dissolved in ethyl acetate. The organic layer was washed with saturated aqueous NaHCO<sub>3</sub>, H<sub>2</sub>O  
25 and dried over MgSO<sub>4</sub>. Concentration *in vacuo* and chromatography on silica eluting with ethyl acetate/hexane provided the tetrahydropyranyl-protected hydroxamate as a white foam (1.65 g, 98.2%).

30 Part D: To a solution of 4N HCl in dioxane (7.35 mL, 29.4 mmol) was added a solution of the tetrahydropyranyl-protected hydroxamate of part C (1.65 g, 2.94 mmol) in methanol (1 mL) and dioxane (3

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mL), and the solution was stirred at ambient temperature for 3 hours. Concentration *in vacuo* and trituration with diethyl ether provided the title compound as a white solid (1.2 g, 79.5%). Analytical  
5 calculation for  $C_{24}H_{32}N_2O_6S \cdot HCl \cdot 0.5H_2O$ : C, 55.22; H, 6.56; N, 5.37; S, 6.14. Found: C, 55.21; H, 6.41; N, 5.32; S, 6.18.

Example 418: Preparation of N-hydroxy-1-(2-methoxyethyl)-4-[[4-(trifluoromethyl)-4-(4-(trifluoromethoxy)phenyl)sulfonyl}-4-  
10 piperidinecarboxamide, monohydrochloride



15 Part A: To a solution of ethyl-4-[(4-fluorophenylsulfonyl)]-1-(2-methoxyethyl)-4-piperidinecarboxylate (6 g, 16.0 mmol) and powdered  $K_2CO_3$  (4.44 g, 32 mmol) in N,N-dimethylformamide (50  
20 mL) was added 4-trifluoromethylphenol (5.72 g, 32 mmol) at ambient temperature, and the solution was heated to ninety degrees Celsius for 48 hours. The solution was concentrated under high vacuum and the residue was dissolved in ethyl acetate. The organic  
25 layer was washed with 1N NaOH,  $H_2O$  and dried over  $MgSO_4$ . Chromatography on silica eluting with ethyl acetate/hexane provided the desired diaryl ether as a light yellow gel (2.66 g, 32.1%).

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Part B: To a solution of the diaryl ether of part A (1.5 g, 2.9 mmol) in ethanol (3 mL) and tetrahydrofuran (3 mL) was added NaOH (1.22 g, 29 mmol) in H<sub>2</sub>O (6 mL) at ambient temperature. The solution was then heated to sixty degrees Celsius for 18 hours. The solution was concentrated *in vacuo* and diluted with water. The aqueous layer was extracted with diethyl ether and acidified to pH=2. Vacuum filtration of the white precipitate provided the desired acid as a white solid (1.0 g, 70.9%).

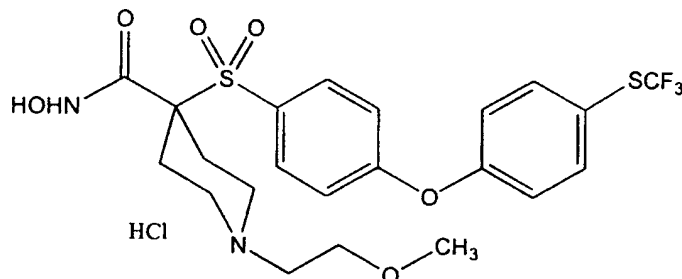
Part C: To the solution of the acid of part B (1.0 g, 2.05 mmol), N-methyl morpholine (0.68 mL, 6.1 mmol), 1-hydroxybenzotriazole (0.84 g, 6.15 mmol) and O-tetrahydropyranyl hydroxyl amine (0.5 g, 4.1 mmol) in N,N-dimethylformamide (20 mL) was added 1-[3-(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (1.18 g, 6 mmol), and solution was stirred at ambient temperature for 24 hours. The solution was concentrated under high vacuum and the residue was dissolved in ethyl acetate. The organic layer was washed with saturated NaHCO<sub>3</sub>, H<sub>2</sub>O and dried over MgSO<sub>4</sub>. Concentration *in vacuo* and chromatography on silica eluting with ethyl acetate/hexane provided the tetrahydropyranyl-protected hydroxamate as a white foam (1.16 g, 96.7%).

Part D: To a solution of 4N HCl in dioxane (5 mL, 20 mmol)) was added a solution of the tetrahydropyranyl-protected hydroxamate of part C (1.16 g, 2 mmol) in methanol (1 mL) and dioxane (3 mL) and was stirred at ambient temperature for 3 hours. Concentration *in vacuo* and trituration with diethyl ether provided the title compound as a white solid (0.79 g, 74.5%). Analytical calculation for

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$C_{22}H_{25}N_2O_6SF_3 \cdot HCl$ : C, 49.03; H, 4.86; N, 5.20; S, 5.95.  
Found: C, 48.85; H, 4.60; N, 5.22; S, 6.13.

5 Example 419: Preparation of N-hydroxy-1-(2-methoxyethyl)-4-[[4-[4-[(trifluoromethyl)thio]phenoxy]phenyl]sulfonyl]-4-piperidinecarboxamide,  
monohydrochloride



Part A: To a solution of ethyl-4-[(4-fluorophenylsulfonyl)]-1-(2-methoxyethyl)-4-piperidinecarboxylate (5 g, 13.4 mmol) and powdered  
15  $K_2CO_3$  (3.7 g, 27 mmol) in N,N-dimethylformamide (20 mL) was added 4-(trifluoromethylthio)phenol (3.9 g, 20 mmol) at ambient temperature, and solution was heated to ninety degrees Celsius for 24 hours. The solution was concentrated under high vacuum, and the  
20 residue was dissolved in ethyl acetate. The organic layer was washed with 1N NaOH,  $H_2O$  and dried over  $MgSO_4$ . Chromatography on silica eluting with ethyl acetate/hexane provided the desired diaryl ether as a light yellow gel (5.94 g, 81.04%).

25 Part B: To a solution of the diaryl ether of part A (5.94 g, 210 mmol) in ethanol (10 mL) and tetrahydrofuran (10 mL) was added NaOH (4.34 g, 108 mmol) in  $H_2O$  (20 mL) dropwise at ambient temperature.

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The solution was then heated to sixty degrees Celsius for 24 hours and ambient temperature for another 24 hours. The solution was concentrated in vacuo and diluted with water. The aqueous layer was extracted with diethyl ether and acidified to pH=2. Vacuum filtration of the white precipitate provided the acid as a white solid (5.5 g, quantitative yield).

Part C: To the solution of the acid of part B (5.5 g, 10.8 mmol), N-methyl morpholine (3.6 mL, 32.4 mmol), 1-hydroxybenzotriazole (4.4 g, 32.4 mmol) and O-tetrahydropyranyl hydroxyl amine (2.6 g, 21.8 mmol) in N,N-dimethylformamide (200 mL) was added 1-[3-(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (6.2 g, 32.4 mmol), and the solution was stirred at ambient temperature for 24 hours. The solution was concentrated under high vacuum and the residue was dissolved in ethyl acetate. The organic layer was washed with saturated aqueous NaHCO<sub>3</sub>, H<sub>2</sub>O and dried over MgSO<sub>4</sub>. Concentration in vacuo and chromatography on silica eluting with ethyl acetate/hexane provided the tetrahydropyranyl-protected hydroxamate as a white foam (4.66 g, 69.8%).

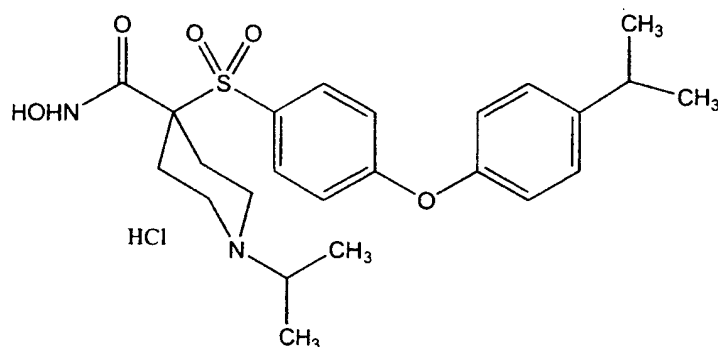
Part D: To a solution of 4N HCl in dioxane (20 mL, 79 mmol) was added a solution of the tetrahydropyranyl-protected hydroxamate of part C (4.65 g, 7.9 mmol) in methanol (2.5 mL) and dioxane (8 mL) and was stirred at ambient temperature for 3 hours. Concentration in vacuo and trituration with diethyl ether provided the title compound as a white solid (3.95 g, 92.1%). Analytical calculation for C<sub>22</sub>H<sub>25</sub>N<sub>2</sub>O<sub>6</sub>S<sub>2</sub>F<sub>3</sub>.HCl: C, 46.27; H, 4.59; N, 4.91; S, 11.23. Found: C, 46.02; H, 4.68; N, 4.57; S, 11.11.



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Example 420: Preparation of N-hydroxy-1-(1-methylethyl)-4-[[4-[4-(1-methylethyl)-phenoxy]phenyl]sulfonyl]-4-piperidinecarboxamide,  
5 monohydrochloride

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10 Part A: To a solution of the product of Example 9, Part D (30 g, 161 mmol) in dichloromethane (40 mL) cooled to zero degrees Celsius was added trifluoroacetic acid (30 mL), and the solution was stirred at ambient temperature for 1 hour.

15 Concentration *in vacuo* provided the trifluoroacetate salt as a light yellow gel. To the solution of the trifluoroacetate salt and triethylamine (28 mL, 201 mmol) in dichloromethane (250 mL) cooled to zero degrees Celsius, were added acetone (24 mL, 320 mmol)

20 and sodium triacetoxyborohydride (68 g, 201 mmol) in small portions followed by addition of acetic acid (18.5 mL, 320 mmol), and solution was stirred at ambient temperature for 48 hours. Then, the dichloromethane was evaporated under high vacuum and

25 the residue was diluted with diethyl ether. The organic layer was washed with 1N NaOH, water and

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dried over  $\text{MgSO}_4$ . Concentration *in vacuo* provided the isopropyl amine as a light yellow gel (21.03 g, 72.8%).

Part B: To a solution of isopropyl amine (4 g, 11.2 mmol) of part A and powdered  $\text{K}_2\text{CO}_3$  (3.09 g, 22.4 mmol) in *N,N*-dimethylformamide (30 mL) was added 4-isopropylphenol (3.05 g, 22 mmol) at ambient temperature and the solution was heated to ninety degrees Celsius for 25 hours. The solution was concentrated under high vacuum and the residue was dissolved in ethyl acetate. The organic layer was washed with 1N NaOH,  $\text{H}_2\text{O}$  and dried over  $\text{MgSO}_4$ . Chromatography on silica eluting with ethyl acetate/hexane provided the desired diaryl ether as a light yellow gel (5.10 g, 96.2%).

Part C: To a solution of the diaryl ether of part B (5.10 g, 10.77 mmol) in ethanol (10 mL) and tetrahydrofuran (10 mL) was added NaOH (4.3 g, 108 mmol) in  $\text{H}_2\text{O}$  (20 mL) from an addition funnel at ambient temperature. The solution was then heated to sixty degrees Celsius for 24 hours and at ambient temperature for another 24 hours. The solution was concentrated *in vacuo* and diluted with water. The aqueous layer was extracted with diethyl ether and acidified to pH=2. Vacuum filtration of the white precipitate provided the desired acid as a white solid (4.80 g, quantitative yield).

Part D: To the solution of the acid of part C (4.80 g, 10.8 mmol), *N*-methyl morpholine (3.6 mL, 32.4 mmol), 1-hydroxybenzotriazole (4.4 g, 32.4 mmol) and *O*-tetrahydropyranyl hydroxyl amine (2.6 g, 21.6 mmol) in *N,N*-dimethylformamide (100 mL) was added 1-[3-(dimethylamino)propyl]-3-ethylcarbodiimide

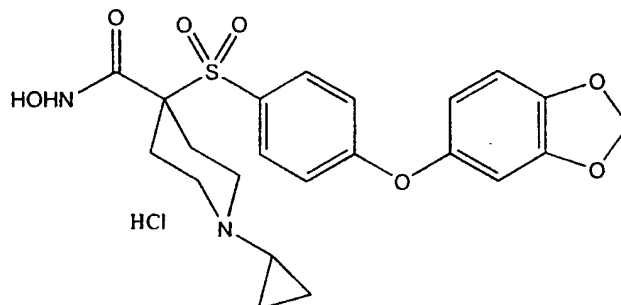
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hydrochloride (6.17 g, 32.4 mmol), and the solution was stirred at ambient temperature for 7 days. The solution was filtered to eliminate the unreacted starting material and the filtrate was concentrated under high vacuum. The residue was dissolved in ethyl acetate and the organic layer was washed with saturated aqueous  $\text{NaHCO}_3$ ,  $\text{H}_2\text{O}$  and dried over  $\text{MgSO}_4$ . Concentration *in vacuo* and chromatography on silica eluting with ethyl acetate/hexane provided the tetrahydropyranyl-protected hydroxamate as a white foam (2.45 g, 41.7%).

Part E: To a solution of 4N HCl in dioxane (11.2 mL, 45 mmol) was added a solution of the tetrahydropyranyl-protected hydroxamate of part D (2.45 g, 11.03 mmol) in methanol (4 mL) and dioxane (8 mL) and was stirred at ambient temperature for 3 hours. Concentration *in vacuo* and tituration with diethyl ether provided the title compound as a white solid (2.01 g, 89.7%). Analytical calculation for  $\text{C}_{24}\text{H}_{32}\text{N}_2\text{O}_5\text{S} \cdot \text{HCl} \cdot 0.5\text{H}_2\text{O}$ : C, 56.96; H, 6.77; N, 5.54; S, 6.34. Found: C, 56.58; H, 6.71; N, 5.44; S, 6.25.

Example 421: Preparation of 4-[[4-(1,3-benzodioxol-5-yloxy)phenyl]sulfonyl]-1-cyclopropyl-N-hydroxy-4-piperidinecarboxamide, monohydrochloride

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Part A : To a solution of the product of Example 9, Part D (9.0 g, 22.0 mmol) in DMF (30 mL) was added  $K_2CO_3$  (4.55 g, 33 mmol), and sesamol (4.55 g, 33 mmol). The solution was stirred at ninety degrees Celsius for 24 hours. The solution was diluted with  $H_2O$  (400 mL) and extracted with ethyl acetate. The organic layer was washed with saturated NaCl and dried over  $MgSO_4$ , filtered and concentrated *in vacuo*. Chromatography on silica gel eluting with 10% ethyl acetate/hexane provided the desired ester as an oil (9.3 g, 79%). HRMS  $MH^+$  calculated for  $C_{26}H_{31}NSO_9$ : 534.1798, found 534.1796..

Part B: To a solution of the ester of part A (9.3 g, 17 mmol) in ethyl acetate (100 mL) cooled to zero degrees C was bubbled gaseous HCl for 10 minutes. The reaction was stirred at this temperature for 0.5 hours. The solution was concentrated *in vacuo* to give the hydrochloride salt (7.34 g, 92%). MS  $MH^+$  calculated for  $C_{21}H_{23}NSO_7$ : 434.1273, found 434.1285..

Part C: To a solution of the hydrochloride salt of part B (7.34 g, 15.6 mmol) in methanol (60 mL) was added acetic acid (8.94 mL, 156 mmol), a portion (about 2 g) of 4-Å molecular sieves, (1-ethoxycyclopropyl)-oxytrimethyl silane (18.82 mL, 93.6 mmol) and sodium cyanoborohydride (4.41 g, 70.2

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mmol). The solution was refluxed for 8 hours. The precipitate was removed by filtration and the filtrate concentrated in vacuo. The residue was diluted with H<sub>2</sub>O (400 mL) and extracted with ethyl acetate. The organic layer was washed with saturated NaCl and dried over MgSO<sub>4</sub>, filtered and concentrated in vacuo. Chromatography on silica gel eluting with 100% ethyl acetate) provided the desired cyclopropyl amine as a solid (7.9 gm, 100%). MS MH<sup>+</sup> calculated for C<sub>24</sub>H<sub>27</sub>NSO<sub>2</sub>: 474.1586, found 474.1599.

Part D: To a solution of cyclopropyl amine from part C (7.9 g, 16.7 mmol) in ethanol (50 mL) and tetrahydrofuran (50 mL) was added a solution of NaOH (6.68 g, 166.8 mmol) in water (30 mL) and the solution was heated at sixty degrees Celsius for 18 hours.

The solution was concentrated in vacuo and the aqueous residue was acidified to pH=3. The resulting precipitate was filtered to give desired carboxylic acid (6.14 g, 76%). MS MH<sup>+</sup> calculated for C<sub>22</sub>H<sub>25</sub>NSO<sub>2</sub>: 446.1273. Found 446.1331.

Part E: To a solution of the carboxylic acid of part D (6.14 g, 12.7 mmol) in DMF (60 mL) was added 1-morpholine (4.2 mL, 38.0 mmol) and O-tetrahydropyranyl hydroxyl amine (2.23 g, 19.0 mmol) followed by 1,3-(dimethylamino)propyl-3-

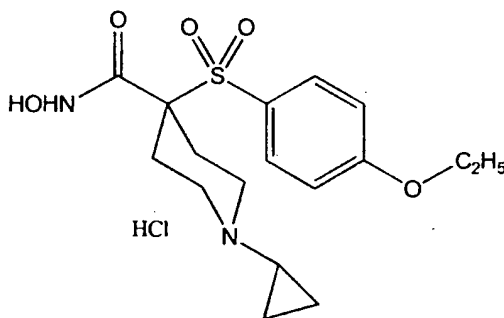
ethylcarbodiimide hydrochloride (3.41 g, 17.8 mmol). The solution was stirred at ambient temperature for 18 hours. The solution was diluted with H<sub>2</sub>O (400 mL) and extracted with ethyl acetate. The organic layer was washed with saturated NaCl and dried over MgSO<sub>4</sub>, filtered and concentrated in vacuo. Chromatography on silica gel eluting with 40% ethyl acetate/hexane

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provided the desired tetrahydropyranyl-protected hydroxamate as a solid (6.67 g, 96%).

Part F: To a solution of tetrahydropyranyl-protected hydroxamate of part E (6.67 g, 12.0 mmol) in dioxane (70 mL) was added 4 N HCl/dioxane (6.6 mL). After stirring at ambient temperature for 3 hours, the solution was concentrated *in vacuo*. Chromatography on a C18 reverse phase column, eluting with acetonitrile/(HCl)water, provided a white solid (4.21 gm, 69%). MS  $MH^+$  calculated for  $C_{22}H_{24}N_2SO_7$ : 461.1382. Found 461.1386.

Example 422: Preparation of 1-cyclopropyl-4-[[4-(4-ethoxyphenoxy)phenyl]sulfonyl]-N-hydroxy-4-piperidinecarboxamide, monohydrochloride



Part A: To a solution of the product of Example 9, Part D (8.0 g, 19.2 mmol) in DMF (30 mL) was added  $K_2CO_3$  (4.00 g, 28.8 mmol) and 4-ethoxyphenol (3.99 g, 28.8 mmol). The solution was stirred at ninety degrees Celsius for 24 hours. The solution was diluted with  $H_2O$  (400 mL) and extracted with ethyl acetate. The organic layer was washed with saturated NaCl and dried over  $MgSO_4$ , filtered and concentrated

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*in vacuo*. Chromatography on silica gel eluting with 10% ethyl acetate/hexane provided the desired ester as an oil (9.62 g, 94 %). MS  $MH^+$  calculated for  $C_{27}H_{35}NSO_8$ : 534.2162. Found 534.2175.

5        Part B: To a solution of ester of part A (9.62 g, 18 mmol) in ethyl acetate (100 mL) cooled to zero degrees Celcius was bubbled gaseous HCl for 5 minutes. The reaction was stirred at this temperature for 0.5 hours. The solution was then  
10 concentrated *in vacuo* to give a the hydrochloride salt (8.1 g, 96%). MS  $MH^+$  calculated for  $C_{22}H_{27}NSO_6$ : 434.1637. Found 434.1637.

      Part C: To a solution of the hydrochloride salt of part B (8.1 g, 17.2 mmol) in methanol (70 mL) was  
15 added acetic acid (9.86 mL, 172 mmol), a portion of 4-Å molecular sieves (ca. 2 g), (1-ethoxycyclopropyl)-oxytrimethyl silane (20.7 mL, 103 mmol) and sodium cyanoborohydride (4.86 g, 77.4 mmol). The solution was refluxed for 8 hours. The  
20 precipitate was removed by filtration and the filtrate was concentrated *in vacuo*. The residue was diluted with  $H_2O$  (400 mL) and extracted with ethyl acetate. The organic layer was washed with 1 N NaOH, saturated NaCl and dried over  $MgSO_4$ , filtered and  
25 concentrated *in vacuo*. Trituration with diethyl ether provided the desired cyclopropyl amine as a white solid (6.84 g, 84%).

      Part D: To a solution of cyclopropyl amine from part C (6.84gm, 14.0 mmol) in ethanol (50 mL) and  
30 tetrahydrofuran (50 mL) was added a solution of NaOH (5.60 g, 140 mmol) in water (30 mL) and the solution was heated at sixty degrees Celsius for 18 hours. The solution was concentrated *in vacuo* and the

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aqueous residue was acidified to pH=3. Filtration gave the desired acid (6.07 g, 88%). MS  $MH^+$  calculated for  $C_{22}H_{27}NSO_6$ : 446. Found 446.

Part E: To a solution of the acid of part D  
5 (6.07g, 12.6 mmol) in DMF (60 mL) was added 1-hydroxybenzotriazole (2.04 g, 15.1 mmol), N-methylmorpholine (4.15 mL, 37.8 mmol) and O-tetrahydropyranyl hydroxyl amine (2.21 g, 18.9 mmol) followed by 1,3-(dimethylamino)propyl-3-ethylcarbodiimide hydrochloride (3.38 g, 17.6 mmol).  
10 The solution was stirred at ambient temperature for 18 hours. The solution was diluted with  $H_2O$  (400 mL) and extracted with ethyl acetate. The organic layer was washed with saturated NaCl and dried over  $MgSO_4$ ,  
15 filtered and concentrated in vacuo. Chromatography on silica gel eluting with 60% ethyl acetate/hexane provided the desired tetrahydropyranyl-protected hydroxamate as a white foam (6.29 g, 92%). MS  $MH^+$  calculated for  $C_{28}H_{36}N_2SO_7$ : 545.2321. Found 545.2316.

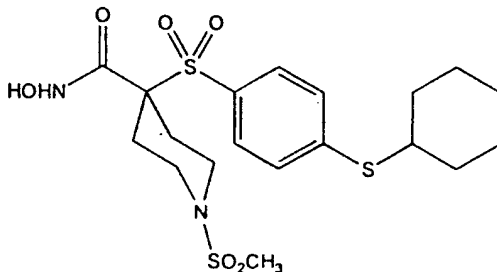
20 Part F: To a solution of the tetrahydropyranyl-protected hydroxamate of part E (2.84 g, 5.0 mmol) in dioxane (40 mL) was added 4 N HCl/dioxane (30 mL). After stirring at ambient temperature for 2.5 hours, the solution was concentrated in vacuo. Trituration  
25 of the resulting solid with diethyl ether and filtration gave the desired hydroxamate as a white solid (2.33 g, 90%). MS  $M^+$  calculated for  $C_{23}H_{28}N_2SO_6$ : 460.1677. Found 460.1678.



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Example 423: Preparation of 4-[[4-(cyclohexylthio)-phenyl]sulfonyl]-N-hydroxy-1-(methylsulfonyl)-4-piperidinecarboxamide

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Part A: To a solution of the product of Example 9, Part D (10.0 g, 24.0 mmol) in DMF (20 mL) was added K<sub>2</sub>CO<sub>3</sub> (4.99 g, 36.0 mmol), cyclohexyl mercaptan (4.40 g, 36.0 mmol). The solution was stirred at ninety degrees Celsius for 48 hrs. The solution was diluted with H<sub>2</sub>O (400 mL) and extracted with ethyl acetate. The organic layer was washed with saturated NaCl and dried over MgSO<sub>4</sub>, filtered and concentrated in vacuo. Trituration with ethanol provided the desired sulfide as a white solid (7.16 g, 58%).

Part B: To a solution of sulfide from part B (9.46 g, 18.5 mmol) in ethanol (30 mL) and tetrahydrofuran (30 mL) was added a solution of NaOH (7.39 g, 185 mmol) in water (15 mL) and the solution was heated at sixty-five degrees Celsius for 18 hours. The solution was concentrated in vacuo and the aqueous residue was acidified to pH = 3.5. The resulting white solid was collected by filtration washed with H<sub>2</sub>O and ethyl ether to give desired carboxylic acid (8.57 g, 95%).

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Part C: To a solution of carboxylic acid of part B (8.3 g, 17.0 mmol) in ethyl acetate (200 mL) cooled to zero degrees Celsius was bubbled gaseous HCl for 15 min. The reaction was then stirred at this temperature for 0.5 hour. The solution was concentrated in vacuo to afford a residue which was triturated with diethyl ether to afford the desired hydrochloride salt as a white solid (7.03 g, 98%). MS MH<sup>+</sup> calculated for C<sub>18</sub>H<sub>25</sub>NS<sub>2</sub>O<sub>4</sub>: 384.1303. Found 10 384.1318.

Part D: To a solution of the hydrochloride salt of part C (1.0 g, 2.4 mmol) was added N-methyl morpholine (654 mL, 5.9 mmol) followed by mesyl chloride (280 mL, 3.6 mmol) in methylene chloride (20 mL). The solution was stirred at ambient temperature for 18 hours. The solution was diluted with H<sub>2</sub>O (400 mL) and extracted with methylene chloride. The organic layer was washed with water, saturated NaCl and dried over MgSO<sub>4</sub>, filtered and concentrated in vacuo to yield the desired methanesulfonamide as a foam (1.0 g, quantitative yield).

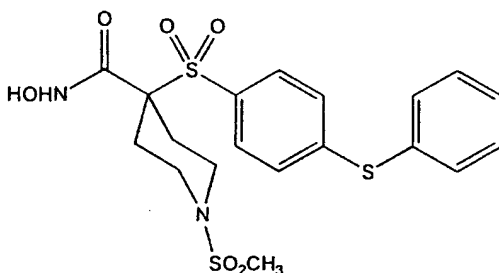
Part E: To a solution of the methanesulfonamide of part D (1.3 g, 2.9 mmol) in DMF (30 mL) was added 1-hydroxybenzotriazole (474 mg, 3.5 mmol), N-methyl morpholine (956 mL, 8.7 mmol), tetrahydropyranyl hydroxyl amine (509 mg, 4.3 mmol) followed by 1-3-(dimethylamino)propyl-3-ethylcarbodiimide (778 mg, 4.06 mmol). The solution was stirred at ambient temperature for 18 hours. The solution was diluted with H<sub>2</sub>O (400 mL) and extracted with ethyl acetate. The organic layer was washed with saturated NaCl and dried over MgSO<sub>4</sub>, filtered and concentrated in vacuo. Chromatography on silica 30

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gel eluting with 30% ethyl acetate/hexane provided the desired tetrahydropyranyl-protected hydroxamate as a white foam (1.05 g, 82%).

Part F: To a solution of the tetrahydropyranyl-protected hydroxamate of part E (1.05 g, 1.97 mmol) in dioxane (30 mL) was added 4 N HCl/dioxane (10 mL). After stirring at ambient temperature for 2.5 hours, the solution was concentrated *in vacuo*. Chromatography on C18 reverse phase column eluting with acetonitrile/(HCl) water provided a white solid (602 mg, 64%). MS  $M^+$  for  $C_{19}H_{28}N_2S_3O_6$ : 477, found 477.

Example 424: Preparation of N-hydroxy-1-(methylsulfonyl)-4-[[4-(phenylthio)-phenyl]sulfonyl]-4-piperidinecarboxamide



Part A: To a solution of the product of Example 9, Part D (40.0 g, 96.0 mmol) in DMF (200 mL) was added  $K_2CO_3$  (20 g, 144 mmol) and thiophenol (22.2 g, 144 mmol). The solution was stirred at ambient temperature for 24 hrs. The solution was then diluted with  $H_2O$  (1 L) and extracted with ethyl acetate. The organic layer was washed with water, saturated NaCl and dried over  $MgSO_4$ , filtered and concentrated *in vacuo*. Chromatography (on silica,

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elueting with 15% ethyl acetate/hexane) provided the desired sulfide as a white solid (44.4 g, 91%).

Part B: To a solution of sulfide of part A (31.2 g, 6.6 mmol) in ethyl acetate (500 mL) cooled to zero degrees Celsius was bubbled gaseous HCl for 30 minutes. The reaction was stirred at this temperature for 1.5 hours. The solution was concentrated in vacuo and resulting solid was triturated with diethyl ether to provide the hydrochloride salt as a white solid (26.95 g, 96%).

Part C: To a solution of the hydrochloride salt of part B (2.0 g, 4.7 mmol), were added N-methyl morpholine (1.29 mL, 11.7 mmol), followed by mesyl chloride (550 mL, 7.05 mmol) in methylene chloride (35 mL). The solution was stirred at ambient temperature for 48 hours. The solution was diluted with H<sub>2</sub>O (400 mL) and extracted with methylene chloride. The organic layer was washed with water, saturated NaCl and dried over MgSO<sub>4</sub>, filtered and concentrated in vacuo to yield the desired methanesulfonamide as a white solid (2.17 gm, 96%).

Part D: To a solution of the methane sulfonamide from part C (2.1 g, 4.3 mmol) in ethanol (25 mL) and tetrahydrofuran (25 mL) was added a solution of NaOH (1.72 g, 43 mmol) in water (10 mL) and the solution was heated at sixty degrees Celsius for 18 hours. The solution was concentrated in vacuo and the aqueous residue was acidified to pH=3.5. The resulting precipitate was filtered to give the desired carboxylic acid as a white solid (2.1 g, quantitative yield).

Part E: To a solution of the carboxylic acid of part D (1.98 g, 4.3 mmol) in DMF (30 mL) were added

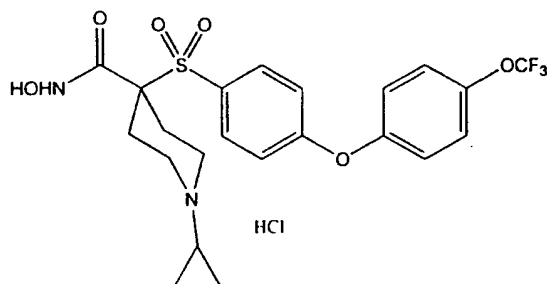
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1-hydroxybenzotriazole (705 mg, 5.2 mmol), N-methyl morpholine (1.54 mL, 12.9 mmol) and O-tetrahydropyranyl hydroxyl amine hydrochloride (755 mg, 6.5 mmol) followed by 1-3-(dimethylamino) propyl]-3-ethyl carbodiimide hydrochloride (1.17 g, 6.1 mmol). The solution was stirred at ambient temperature for 5 days. The solution was diluted with H<sub>2</sub>O (400 mL) and extracted with ethyl acetate. The organic layer was washed with saturated NaCl and dried over MgSO<sub>4</sub>, filtered and concentrated *in vacuo*. Chromatography on C18 reverse phase column, eluting with acetonitrile/(HCl) water provided the desired tetrahydropyranyl-protected hydroxamate as a white solid (1.86 g, 80%). HRMS MH<sup>+</sup> calculated for C<sub>24</sub>H<sub>30</sub>N<sub>2</sub>S<sub>3</sub>O<sub>7</sub>: 555.1293, found 555.1276.

Part F: To a solution of tetrahydropyranyl-protected hydroxamate of part E (1.86 g, 3.5 mmol) in dioxane (30 mL) and methanol (10 mL) was added 4 N HCl/dioxane (20 mL). After stirring at ambient temperature for 2.5 hours, the solution was concentrated *in vacuo*. Chromatography on a C18 reverse phase column eluting with acetonitrile/(HCl) water provided the title compound as a white solid (1.48 gm, 91%). HRMS MH<sup>+</sup> calculated for C<sub>19</sub>H<sub>22</sub>N<sub>2</sub>S<sub>3</sub>O<sub>6</sub>: 471.0718 Found 471.0728.

Example 425: Preparation of 1-cyclopropyl-N-hydroxy-4-[[4-[4-(trifluoromethoxy)phenoxy]-phenyl]sulfonyl]-4-piperidine-carboxamide, monohydrochloride

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Part A: To a solution of the product of Example 398, Part A (6.97 g, 19.6 mmol) in DMF (500 mL) was added  $K_2CO_3$  (3.42 g, 18.0 mmol) and 4-(trifluoromethoxy)-phenol (3.7 g, 24.8 mmol). The solution was stirred at ninety degrees Celsius for 40 hours. The solution was diluted with  $H_2O$  (600 mL) and extracted with ethyl acetate. The organic layer was washed with water, saturated NaCl and dried over  $MgSO_4$ , filtered and concentrated *in vacuo* to afford the desired diaryl ether as an oil (8.5 g, quantitative). HRMS  $MH^+$  calculated for  $C_{24}H_{26}NSO_6F_3$ : 514.1511. Found 514.1524.

Part B: To a solution of diaryl ether from part A (8.4 g, 16.4 mmol) in ethanol (50 mL) and tetrahydrofuran (50 mL) was added a solution of NaOH (6.54 g, 164 mmol) in water (20 mL) and the solution was heated at sixty degrees Celsius for 18 hours. The solution was concentrated *in vacuo* to remove most of organic solvents and the aqueous residue was acidified to pH=4.0. The resulting precipitate was filtered to give the desired filtered to give the hydrochloride salt as a white solid (5.01 g, 63%). HRMS  $MH^+$  calculated for  $C_{22}H_{22}NSO_6F_3$ : 486.1198, found 486.1200.

Part C: To a solution of the hydrochloride salt of part B (5.0 g, 10.3 mmol) in DMF (80 mL) were added 1-hydroxybenzotriazole (1.65 g, 12.3 mmol), N-

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methyl morpholine (3.4 mL, 30.9 mmol) and O-tetrahydropyranyl hydroxyl amine hydrochloride (1.8 g, 15.4 mmol) followed by 1-3-(dimethylamino)propyl-3-ethylcarbodiimide hydrochloride (1.60 g, 12.3 mmol). The solution was stirred at ambient temperature for 42 hours. The solution was diluted with H<sub>2</sub>O (400 mL) and extracted with ethyl acetate. The organic layer was washed with saturated NaCl and dried over MgSO<sub>4</sub>, filtered and concentrated in vacuo.

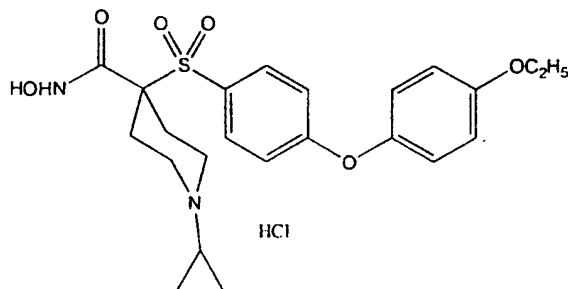
10 Chromatography on silica gel, eluting with 30% ethyl acetate/hexane provided the desired tetrahydropyranyl-protected hydroxamate as a white solid (5.41 g, 89%).

Part D: To a solution of tetrahydropyranyl-protected hydroxamate of part C (5.4 g, 9.2 mmol) in dioxane (80 mL) and methanol (20 mL) was added 4 N HCl/dioxane (50 mL). The reaction was stirred at ambient temperature for 2.5 hours, the solution was concentrated in vacuo. Trituration with diethyl ether afforded the title compound as a white solid (4.02 g, 81%). HRMS MH<sup>+</sup> calculated for C<sub>22</sub>H<sub>23</sub>N<sub>2</sub>SO<sub>6</sub>F<sub>3</sub>: 501.1307, found 501.1324.

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Example 426: Preparation of 1-cyclopropyl-4-[(4-ethoxyphenyl) sulfonyl]-N-hydroxy-4-piperidinecarboxamide, monohydrochloride

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Part A: To a solution of the product of Example 398, Part A (5.87 g, 16.5 mmol) in DMF (50 mL) was added  $K_2CO_3$  (3.42 g, 24.7 mmol) and  $\alpha,\alpha,\alpha$ -(trifluoromethyl)-p-cresol (4.01g, 24.7 mmol). The solution was stirred at ninety degrees Celsius for 48 hours. The solution was diluted with  $H_2O$  (400 mL) and extracted with ethyl acetate. The organic layer was washed with water, saturated NaCl and dried over  $MgSO_4$ , filtered and concentrated *in vacuo* to give the crude product, containing a large percentage of starting material (8.39 g). To this material (8.39 g) in ethanol (50 mL) and tetrahydrofuran (50 mL) was added a solution of NaOH (6.75 g, 169 mmol) in water (20 mL) and the solution was heated at sixty degrees Celsius for 18 hours. The solution was concentrated *in vacuo* and the aqueous residue was acidified to pH=3.5. The resulting precipitate was filtered to give the desired hydrochloride salt as a waxy solid (5.04 g, 64%).

Part B: To a solution of the hydrochloride salt of part A (5.0 g, 10.3 mmol) in DMF (80 mL) were added 1-hydroxybenzotriazole (1.73 g, 12.8 mmol), N-methyl morpholine (3.5 mL, 31.8 mmol) and O-tetrahydropyranyl hydroxyl amine hydrochloride (1.86 g, 15.9 mmol) followed by 1-3-(dimethylamino)propyl]-



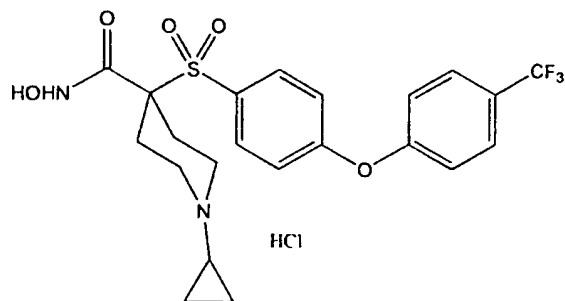
-679-

3-ethylcarbodiimide hydrochloride (2.84 g, 14.8 mmol). The solution was stirred at ambient temperature for 18 hours. The solution was diluted with H<sub>2</sub>O (400 mL) and extracted with ethyl acetate. 5 The organic layer was washed with saturated NaCl and dried over MgSO<sub>4</sub>, filtered and concentrated *in vacuo*. Chromatography on silica gel eluting with 30% ethyl acetate/hexane provided the desired tetrahydropyranyl-protected hydroxamate as a white 10 solid (1.5 g, 32%).

Part C: To a solution of tetrahydropyranyl-protected hydroxamate of part D (1.5 g, 3.3mmol) in dioxane (30 mL) and methanol (15 mL) was added 4 N HCl/dioxane (50 mL). The reaction was stirred at 15 ambient temperature for 2 hours, then the solution was concentrated *in vacuo*. Trituration of the residue with diethyl ether afforded the title compound as a white solid (1.09g, 81%). MS MH<sup>+</sup> for C<sub>17</sub>H<sub>24</sub>N<sub>2</sub>SO<sub>5</sub>: 369 found 369.

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Example 427: Preparation of 1-cyclopropyl-N-hydroxy-4-[[4-[4-(trifluoromethyl)phenoxy]phenyl]sulfonyl]-4-piperidinecarboxamide, 25 monohydrochloride



-680-

Part A: To a solution of the product of Example 398, Part A (5.96 g, 15.0 mmol) in DMF (100 mL) was added  $K_2CO_3$  (12.34 g, 38.0 mmol) and  $\alpha,\alpha,\alpha$ -trifluoromethyl phenol (3.65 g, 22.5 mmol). The solution was stirred ninety degrees Celsius for 28 hours. The solution was diluted with  $H_2O$  (400 mL) and extracted with ethyl acetate. The organic layer was washed with water, saturated NaCl and dried over  $MgSO_4$ , filtered and concentrated in vacuo to afford desired aryl ether as an oil (7.54 g, quantitative)

Part B: To a solution of aryl ether from part A (7.54 g, 15.0 mmol) in ethanol (40 mL) and tetrahydrofuran (40 mL) was added a solution of NaOH (6.06 g, 151.0 mmol) in water (20 mL) and the solution was heated at sixty degrees Celsius for 18 hours. The solution was concentrated in vacuo and the aqueous residue was acidified to pH=2.0. The resulting precipitate was filtered to give the desired hydrochloride salt as a white solid (7.98 g, quantitative). MS  $MH^+$  calculated for  $C_{22}H_{22}NSO_5F_3$ : 470, found 470.

Part C: To a solution of the hydrochloride salt of part B (7.60 g, 15.0 mmol) in DMF (100 mL) were added 1-hydroxybenzotriazole (2.44 g, 18.0 mmol), N-methyl morpholine (3.4 mL, 30.9 mmol) and O-tetrahydropyranyl hydroxyl amine hydrochloride (2.63 g, 22.5 mmol) followed by 1-3-(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (4.02 g, 21.0 mmol). The solution was stirred at ambient temperature for 96 hours. The solution was diluted with  $H_2O$  (400 mL) and extracted with ethyl acetate. The organic layer was washed with saturated NaCl and

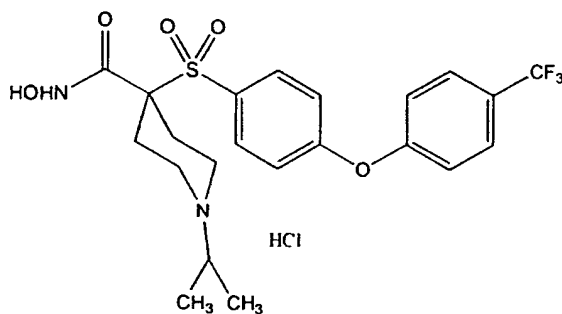
-681-

dried over  $\text{MgSO}_4$ , filtered and concentrated *in vacuo*.  
Chromatography on silica eluting with 30% ethyl  
acetate/hexane provided the desired  
tetrahydropyranyl-protected hydroxamate as a white  
5 solid (5.93g, 69%).

Part D: To a solution of tetrahydropyranyl-  
protected hydroxamate of part C (3.8 g, 6.7 mmol) in  
dioxane (100 mL) was added 4 N HCl/dioxane (30 mL).  
The reaction was stirred at ambient temperature for 2  
10 hours, then the solution was concentrated *in vacuo*.  
Trituration with diethyl ether afforded the title  
compound as a white solid (3.33 g, 96%). MS  $\text{MH}^+$   
calculated for  $\text{C}_{22}\text{H}_{23}\text{N}_2\text{SO}_5\text{F}_3$ : 485, found 485.

15 Example 428: Preparation of N-hydroxy-1-(1-  
methylethyl)-4-[[4-[4-  
(trifluoromethyl)-phenoxy]phenyl]  
sulfonyl]-4-piperidinecarboxamide,  
monohydrochloride

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Part A: To a solution of the product of Example  
9, Part D (30.0 g, 80.8 mmol) in methylene chloride  
25 (100 mL) was added trifluoroacetic acid (30 mL) in  
methylene chloride (40 mL). The solution was stirred  
at ambient temperature for two hours. The solution

was concentrated *in vacuo*. To the residue dissolved in methylene chloride (150 mL) at zero degrees Celsius were added triethylamine (28.0 mL, 277 mmol), acetone (24.0 mL, 413 mmol), sodium cyanoborohydride (68 g, 323.1 mmol) and acetic acid (18.5 mL, 308 mmol). The reaction mixture was stirred at ambient temperature for 18 hours. The solution was diluted with 1N NaOH and extracted with ethyl ether. The organic layer was washed with 1N NaOH, water, saturated NaCl and dried over  $\text{MgSO}_4$ , filtered and concentrated *in vacuo* to provided the desired isopropylamine (21.03 g, 72%).

Part B: To a solution of the isopropylamine of part A (4.04 g, 11.0 mmol) in DMF (50 mL) was added  $\text{CsCO}_3$  (10.75g, 33.3 mmol) and  $\alpha,\alpha,\alpha$ -trifluoro-p-cresol (2.67g, 16.5 mmol). The solution was stirred at ninety degrees Celsius for 40 hours. The solution was diluted with  $\text{H}_2\text{O}$  (400 mL) and extracted with ethyl acetate. The organic layer was washed with water, saturated NaCl and dried over  $\text{MgSO}_4$ , filtered and concentrated *in vacuo*. Chromatography on silica gel, eluting with 30% ethyl acetate/hexane, provided the desired diaryl ether as an oil (5.35 g, 97%). HRMS  $\text{MH}^+$  calculated for  $\text{C}_{24}\text{H}_{28}\text{NSO}_5\text{F}_3$ : 500.1640, found: 500.1678.

Part C: To a solution of the diaryl ether from part B (5.3 g, 10.6 mmol) in ethanol (50 mL) and tetrahydrofuran (50 mL) was added a solution of NaOH (4.2 g, 106.0 mmol) in water (25 mL) and the solution was heated at sixty degrees Celsius for 18 hours. The solution was concentrated *in vacuo* and the aqueous residue was acidified to pH=3.0. The resulting precipitate was filtered to give the

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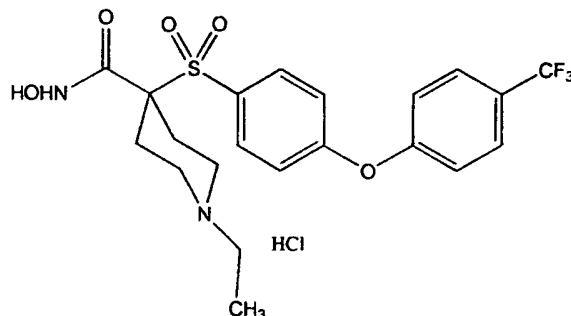
desired hydrochloride salt as a white solid (5.38 g, quantitative). MS  $MH^+$  calculated for  $C_{22}H_{24}NSO_5F_3$ : 472.1406, found 471.472.1407.

Part D: To a solution of the hydrochloride salt of part C (5.4 g, 10.6 mmol) in DMF (90 mL) were added 1-hydroxybenzotriazole (1.72 g, 12.3 mmol), N-methyl morpholine (3.5 mL, 32.0 mmol) and O-tetrahydropyranyl hydroxyl amine hydrochloride (1.87 g, 15.9 mmol) followed by 1-3-(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (2.8 g, 15.0 mmol). The solution was stirred at ambient temperature for 144 hours. The solution was diluted with  $H_2O$  (400 mL) and extracted with ethyl acetate. The organic layer was washed with saturated NaCl and dried over  $MgSO_4$ , filtered and concentrated *in vacuo*. Chromatography on silica gel, eluting with 2% methanol/ethyl acetate, provided the desired tetrahydropyranyl-protected hydroxamate as a white solid (2.74 g, 45%). HRMS  $MH^+$  calculated for  $C_{27}H_{33}N_2SO_5F_3$ : 571.2090, found 571.2103.

Part E: To a solution of tetrahydropyranyl-protected hydroxamate of part D (2.7 g, 4.7 mmol) in dioxane (50 mL) was added 4 N HCl/dioxane (20 mL). The reaction was stirred at ambient temperature for 2 hours. Filtration afforded the title compound as a white solid (2.08 g, 84%). MS  $MH^+$  calculated for  $C_{22}H_{25}N_2SO_5F_3$ : 487., found 487.

Example 429: Preparation of 1-ethyl-N-hydroxy-4-[[4-[4-(trifluoromethyl)phenoxy]phenyl]-sulfonyl]-4-piperidinecarboxamide, monohydrochloride

- 684 -



Part A: To a solution of the product of Example 9, Part D (48 g, 115.0 mmol) in ethyl acetate (750 mL) cooled to zero degrees Celsius was bubbled gaseous HCl for 45 minutes, and stirred at that temperature for 7 hours. The solution was concentrated *in vacuo* to afford a residue that was triturated with diethyl ether to afford the desired hydrochloride salt as a white solid (32.76 g, 81%).

Part B: To a solution of hydrochloride salt of part A (15.8 g, 45.0 mmol) in DMF (75 mL) was added K<sub>2</sub>CO<sub>3</sub> (12.4 g, 90.0 mmol) and bromoethane (3.4 mL, 45.0 mmol). The solution was stirred at ambient temperature for 18 hours. The solution was diluted with H<sub>2</sub>O (200 mL) and extracted with ethyl acetate. The organic layer was washed with water, saturated NaCl and dried over MgSO<sub>4</sub>, filtered and concentrated *in vacuo* to provide the desired ethyl amine as an oil (15.4 g, quantitative).

Part C: To a solution of ethyl amine of part B (5.2 g, 15.0 mmol) in DMF (50 mL) was added CsCO<sub>3</sub> (12.21 g, 37.5 mmol) and  $\alpha,\alpha,\alpha$ -trifluoro-p-cresol (3.65 g, 23.0 mmol). The solution was stirred ninety degrees Celsius for 25 hours. The solution was diluted with H<sub>2</sub>O (400 mL) and extracted with ethyl acetate. The organic layer was washed with water,

saturated NaCl and dried over  $\text{MgSO}_4$ , filtered and concentrated *in vacuo*. Chromatography on silica gel, eluting with 20% ethyl acetate/hexane, provided the desired diaryl ether as an oil (7.3 g, 5 quantitative yield).

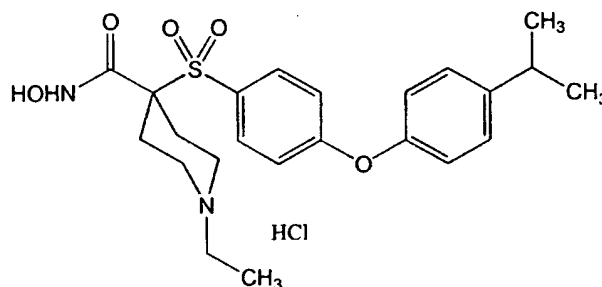
Part D: To a solution of diaryl ether from part C (7.3 g, 15.0 mmol) in ethanol (40 mL) and tetrahydrofuran (40 mL) was added a solution of NaOH (6.0 g, 150 mmol) in water (30 mL), and the solution 10 was heated at sixty degrees Celsius for 16 hours. The solution was concentrated *in vacuo* and the aqueous residue was acidified to pH=4.0. The resulting precipitate was filtered to give the desired hydrochloride salt as a white solid (5.96 g, 15 80%). HRMS  $\text{MH}^+$  calculated for  $\text{C}_{21}\text{H}_{22}\text{NSO}_5\text{F}_3$ : 458.1249, found 458.1260

Part E: To a solution of the hydrochloride salt of part D (5.96 g, 12.0 mmol) in DMF (80 mL) were added 1-hydroxybenzotriazole (1.96 g, 14.0 mmol), N-methyl morpholine (3.9 mL, 36.0 mmol) and O-tetrahydropyranyl hydroxyl amine hydrochloride (2.11 g, 18.0 mmol) followed by 1-3-(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (3.24 g, 17.0 mmol). The solution was stirred at ambient 25 temperature for 168 hours. The insoluble material was removed by filtration and the filtrate was diluted with  $\text{H}_2\text{O}$  (400 mL) and extracted with ethyl acetate. The organic layer was washed with saturated NaCl and dried over  $\text{MgSO}_4$ , filtered and concentrated 30 *in vacuo*. Chromatography on silica gel eluting with 70% ethyl acetate/hexane provided the desired tetrahydropyranyl-protected hydroxamate as a white solid (2.80 g, 41%).

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Part F: To a solution of tetrahydropyranyl-protected hydroxamate of part E (2.8 g, 5.0 mmol) in dioxane (80 mL) was added 4 N HCl/dioxane (20 mL). The reaction was stirred at ambient temperature for 5 hours, and the solution was concentrated in vacuo. Trituration with diethyl ether afforded the title compound as a white solid (2.08 g, 84%). MS  $MH^+$  calculated for  $C_{21}H_{23}N_2SO_5F_3$ : 473, found 473.

- 10 Example 430: Preparation of 1-ethyl-N-hydroxy-4-[[4-[4-(1-methylethyl)phenoxy]phenyl]-sulfonyl]-4-piperidinecarboxamide, monohydrochloride



Part A: To a solution of the product of Example 9, Part D (48 g, 115.0 mmol) in ethyl acetate (750 mL) cooled to zero degrees Celsius was bubbled gaseous HCl for 45 minutes. The reaction was stirred at this temperature for 7 hours. The solution was concentrated in vacuo to afford a residue which was triturated with diethyl ether to afford the desired hydrochloride salt as a white solid (32.8 g, 81%).

25 Part B: To a solution of the hydrochloride salt of part A (15.8 g, 45.0 mmol) in DMF (75 mL) was added  $K_2CO_3$  (12.4 g, 90.0 mmol) and bromoethane (3.4



mL, 45.0 mmol). The solution was stirred at ambient temperature for 18 hours. The solution was diluted with H<sub>2</sub>O (200 mL) and extracted with ethyl acetate. The organic layer was washed with water, saturated NaCl and dried over MgSO<sub>4</sub>, filtered and concentrated in vacuo to afford the desired ethyl amine as an oil (15.4 g, quantitative).

Part C: To a solution of ethyl amine of part B (5.2 g, 15.0 mmol) in DMF (50 mL) was added CsCO<sub>3</sub> (12.2 g, 37.5 mmol) and 4-isopropylphenol (3.15 g, 23.0 mmol). The solution was stirred at ninety degrees Celsius for 5 hours. The solution was diluted with H<sub>2</sub>O (400 mL) and extracted with ethyl acetate. The organic layer was washed with water, saturated NaCl and dried over MgSO<sub>4</sub>, filtered and concentrated in vacuo. Chromatography on silica gel eluting with 20% ethyl acetate/hexane provided the desired diaryl ether as an oil (6.2 g, 95%). HRMS MH<sup>+</sup> calculated for C<sub>25</sub>H<sub>33</sub>N<sub>3</sub>SO<sub>5</sub>: 460.2158, found: 460.2160.

Part D: To a solution of diaryl ether from part C (6.2 g, 13.0 mmol) in ethanol (40 mL) and tetrahydrofuran (40 mL) was added a solution of NaOH (5.2 g, 130 mmol) in water (30 mL) and the solution was heated at sixty degrees Celsius for 16 hours. The solution was concentrated in vacuo and the aqueous residue was acidified to pH = 4.0. The resulting precipitate was filtered and washed with H<sub>2</sub>O and diethyl ether to give desired hydrochloride salt (6.0 g, quantitative). HRMS MH<sup>+</sup> calculated for C<sub>23</sub>H<sub>29</sub>NSO<sub>5</sub>: 432.1845, found 432.1859.

Part E: To a solution of the hydrochloride salt of part D (6.08 g, 13.0 mmol) in DMF (80 mL) were added 1-hydroxybenzotriazole (2.11 g, 15.6 mmol), N-

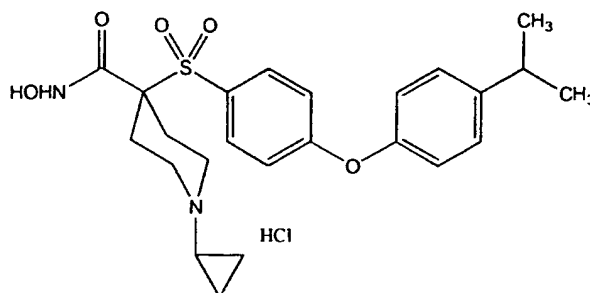
methyl morpholine (4.3 mL, 39.0 mmol) and O-tetrahydropyranyl hydroxyl amine hydrochloride (2.28 g, 19.5 mmol) followed by 1-3-(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (3.49 g, 18.2 mmol). The solution was stirred at ambient temperature for 168 hours. Insoluble material was removed by filtration and the filtrate was diluted with H<sub>2</sub>O (400 mL) and extracted with ethyl acetate. The organic layer was washed with saturated NaCl and dried over MgSO<sub>4</sub>, filtered and concentrated in vacuo. Chromatography on silica gel eluting with 50% ethyl acetate/hexane provided the desired tetrahydropyranyl-protected hydroxamate as a white solid (1.7 g, 25%). HRMS MH<sup>+</sup> calculated for C<sub>28</sub>H<sub>38</sub>N<sub>2</sub>SO<sub>6</sub>: 531.2529, found 531.2537.

Part F: To a solution of tetrahydropyranyl-protected hydroxamate of part E (1.7 g, 3.0 mmol) in dioxane (60 mL) was added 4 N HCl/dioxane (10 mL). The reaction was stirred at ambient temperature for 4 hours, and the solution was concentrated in vacuo. Chromatography on C18 reverse phase column eluting with acetonitrile/(HCl)water provided the title compound as a white solid (860 mg, 59%). HRMS MH<sup>+</sup> calculated for C<sub>23</sub>H<sub>30</sub>N<sub>2</sub>SO<sub>5</sub>: 447.1954, found 447.1972

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Example 431: Preparation of 1-cyclopropyl-N-hydroxy-4-[[4-[4-(1-methylethyl)phenoxy]phenyl]-sulfonyl]-4-piperidine-carboxamide, monohydrochloride

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Part A: To a solution of the product of Example 398, Part A (4.0 g, 10.2 mmol) in DMF (40 mL) was added  $K_2CO_3$  (12.46 g, 38.0 mmol) and 4-isopropylphenol (4.99 g, 15.3 mmol). The solution was stirred at ninety degrees Celsius for 24 hours. The solution was diluted with  $H_2O$  (400 mL) and extracted with ethyl acetate. The organic layer was washed with water, saturated NaCl and dried over  $MgSO_4$ , filtered and concentrated *in vacuo*. Chromatography on silica eluting with 30% ethyl acetate/hexane provided the desired diaryl ether as a white solid (3.89g, 76%). HRMS  $MH^+$  calculated for  $C_{26}H_{33}NSO_5$ : 472.2158, found: 472.2171.

Part B: To a solution of diaryl ether from part A (3.89 g, 8.20 mmol) in ethanol (40 mL) and tetrahydrofuran (40 mL) was added a solution of NaOH (3.30 g, 82.5 mmol) in water (25 mL) and the solution was heated at sixty degrees Celsius for 18 hours. The solution was concentrated *in vacuo* to remove most of the organic solvents and the aqueous residue was acidified to pH=3.0. The resulting precipitate was filtered and washed with  $H_2O$  and ethyl ether to give desired hydrochloride salt (7.98 g, quantitative) as a white solid. MS  $MH^+$  calculated for  $C_{24}H_{29}NSO_5$ : 444, found: 444.

Part C: To a solution of the hydrochloride salt of part B (3.6 g, 7.0 mmol) in DMF (70 mL) were added 1-hydroxybenzotriazole (1.22 g, 9.0 mmol), N-methyl morpholine (2.3 mL, 21.0 mmol) and O-

5 tetrahydropyranyl hydroxyl amine hydrochloride (1.23 g, 10.5 mmol) followed by 1-3-(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (2.01 g, 10.4 mmol). The solution was stirred at ambient temperature for 15 days. The solution was diluted

10 with H<sub>2</sub>O (400 mL) and extracted with ethyl acetate. The organic layer was washed with saturated NaCl and dried over MgSO<sub>4</sub>, filtered and concentrated *in vacuo*. Chromatography on silica gel, eluting with 15% ethyl acetate/hexane, provided the desired

15 tetrahydropyranyl-protected hydroxamate as a white solid (3.51 g, 92%). HRMS MH<sup>+</sup> calculated for C<sub>29</sub>H<sub>38</sub>N<sub>2</sub>SO<sub>6</sub>: 543.2529, found 543.2539.

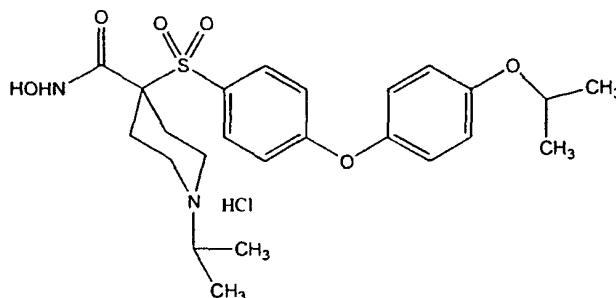
Part D: To a solution of tetrahydropyranyl-protected hydroxamate of part C

20 (3.51 g, 6.0 mmol) in methanol (10 mL) and dioxane (200 mL) was added 4 N HCl/dioxane (30 mL). After stirring at ambient temperature for 2.5 hours, the solution was concentrated *in vacuo*. Trituration with diethyl ether afforded the title compound as a white

25 solid (2.56 g, 86%). MS MH<sup>+</sup> calculated for C<sub>24</sub>H<sub>30</sub>N<sub>2</sub>SO<sub>5</sub>: 459.1875, found 459.1978.

Example 432: Preparation of N-hydroxy-4-[[4-[4-(1-methylethoxy)phenoxy]phenyl]sulfonyl]-1-(1-methylethyl)-4-piperidinecarboxamide, monohydrochloride

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Part A: To a solution of ethyl-4-[(4-fluorophenylsulfonyl)]-1-(1-methylethyl)-4-piperidinecarboxylate (2.0 g, 5.4 mmol) in N,N-dimethylformamide (10 mL) was added 4-isopropoxyphenol, which may be prepared according to the procedure of *J. Indian Chem. Soc.*, **73**, 1996, 507-511, (1.63 g, 10.7 mmol) and cesium carbonate (7 g, 21.5 mmol) and the resulting suspension was heated at 60 degrees Celsius for 16 hours. The reaction mixture was then concentrated *in vacuo*. The residue was dissolved in ethyl acetate and washed with 1 N sodium hydroxide, water and brine and dried over magnesium sulfate. Concentration of the organic phase gave a residue which was purified by chromatography on silica gel eluting with ethyl acetate/hexane to afford the desired aryl ether (1.06 g, 39%).

Part B: To a solution of the aryl ether (1.06 g, 2.1 mmol) in ethanol (20 mL) and water (20 mL) was added sodium hydroxide (0.84 g, 21 mmol) and the mixture was heated to 65 degrees Celsius for 16

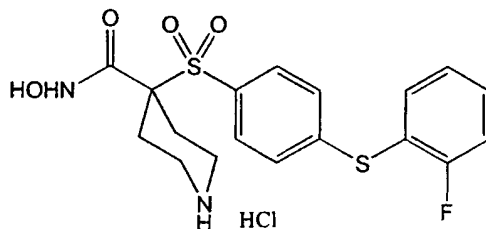
hours. The solvents were then removed *in vacuo*. Water (50 mL) was added and the mixture was again concentrated *in vacuo* and the resulting mixture was acidified with 2 N HCl to pH=4-5. The solid  
5 precipitate was collected by filtration and rinsed with diethyl ether to afford the desired carboxylic acid (3.13 g, 100%).

Part C: A solution of the carboxylic acid of part B (1.0 g, 2.0 mmol) in thionyl chloride (5 mL)  
10 was refluxed for 2 hours. The solvent was removed *in vacuo*. To the resulting residue in DMF (10 mL) was added N-methyl morpholine (0.66 mL, 6.0 mmol) and O-tetrahydropyranyl hydroxyl amine hydrochloride (351 mg, 3.0 mmol). The solution was stirred at  
15 ambient temperature for 18 hours. The suspension was filtered and the filtrate was diluted with H<sub>2</sub>O (400 mL) and extracted with ethyl acetate. The organic layer was washed with saturated NaCl and dried over MgSO<sub>4</sub>, filtered and concentrated *in vacuo*.  
20 Chromatography on silica gel eluting with 90% ethyl acetate/hexane provided the desired tetrahydropyran-protected hydroxamate as a white solid (280 mg, 23%). HRMS MH<sup>+</sup> calculated for C<sub>29</sub>H<sub>40</sub>N<sub>2</sub>SO<sub>7</sub>: 561.2634, found 561.2653.

25 Part D: To a solution of tetrahydropyranyl-protected hydroxamate of part C (275 mg, 0.48 mmol) in dioxane (15 mL) was added 4 N HCl/dioxane (5 mL). After stirring at ambient temperature for 2 hours, the solution was concentrated *in vacuo*. Trituration  
30 with diethyl ether and filtration of the resulting solid gave the title compound as a white solid (193 mg, 76%). MS MH<sup>+</sup> calculated for C<sub>24</sub>H<sub>32</sub>N<sub>2</sub>SO<sub>6</sub>: 477, found 477.

Example 433: Preparation of 4-[[4-[(2-fluorophenyl)-thio]phenyl]sulfonyl]-N-hydroxy-4-piperidinecarboxamide, monohydrochloride

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Part A: To a solution of the product of Example 9, Part D (6.0 g, 14.4 mmol) in N,N-dimethylformamide (30 mL) were added 2-fluorothiophenol (2.22 g, 17.3 mmol) and potassium carbonate (2.40 g, 17.3 mmol), and the resulting suspension was stirred at ambient temperature for 48 hours. The reaction mixture was then diluted with ethyl acetate (200 mL) and washed with 1 N sodium hydroxide (200 mL) and brine (3X). Concentration of the organic phase afforded a residue that was purified by chromatography on silica gel, eluting with ethyl acetate/hexane (1:4), to afford the desired aryl sulfide (8.0 grams, 100%) as a white solid.

Part B: To a solution of the ethyl ester of part A (8.0 g, 15 mmol) in ethanol (90 mL) and water (20 mL) was added sodium hydroxide (6.1 g, 152 mmol), and the mixture was heated to 65 degrees Celsius for 16 hours. Volatile organics were removed in vacuo and the resulting aqueous mixture was acidified with 2 N HCl to pH=3-4. Solid sodium chloride was added and the mixture was extracted with

ethyl acetate. The combined organic extracts were washed with brine and dried with magnesium sulfate. Removal of the solvent afforded the desired carboxylic acid (4.92 g, 68%).

5                   Part C: To a solution of the carboxylic acid of part B (4.92 g, 9.93 mmol) in N,N-dimethylformamide (100 mL) were added 4-methylmorpholine (1.52 g, 15.0 mmol), N-hydroxybenzotriazole (1.62 g, 12.0 mmol) and 1-[3-  
10 (dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (2.70 g, 14.1 mmol), followed by O-(tetrahydro-2H-pyran-2-yl)hydroxylamine (2.24 g, 15.0 mmol). After stirring for 16 hours at ambient temperature, the reaction mixture was concentrated to  
15 a residue that was dissolved in ethyl acetate (200 mL) and washed with water and brine. Concentration and purification by chromatography on silica gel afforded the protected hydroxamate derivative (4.9 mg, 83%).

20                   Part D: Hydrogen chloride gas was bubbled for 10 minutes through an ice bath-cooled solution of the protected hydroxamate of part C (4.9 g, 8.24 mmol) in ethyl acetate (30 mL). The mixture was then allowed to stand at ambient temperature for 2 hours,  
25 after which time the solvent was removed *in vacuo*. Fresh ethyl acetate (30 mL) was added and then removed *in vacuo*, and this procedure was repeated. Ethyl acetate (50 mL) was then added and the solid was collected by filtration to afford a solid that  
30 was purified by reverse-phase chromatography,, eluting with acetonitrile/water (gradient of 20/80 up to 100% acetonitrile), to afford the title compound (1.9 g, 43%). Analytical calculation for

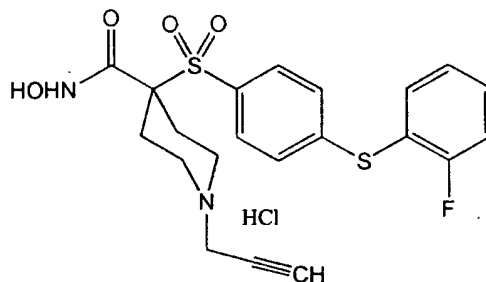


$C_{18}H_{19}FN_2O_4S_2 \cdot HCl$ : C, 48.37; H, 4.51; N, 6.27; Cl, 7.93. Found: C, 48.14; H, 4.33; N, 6.21; Cl, 8.64. HRMS (ESI)  $MH^+$  calculated for  $C_{18}H_{19}FN_2O_4S_2$ : 411.0849, found 411.0844.

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Example 434: Preparation of 4-[[4-[(2-fluorophenyl)-thio]phenyl]sulfonyl]-N-hydroxy-1-(2-propynyl)-4-piperidinecarboxamide, monohydrochloride

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Part A: To a solution of the product of Example 9, Part F (4.46 g, 12.6 mmol) in N,N-dimethylformamide (30 mL) were added 2-fluorothiophenol (1.94 g, 15.1 mmol) and potassium carbonate (2.09 g, 15.1 mmol), and the resulting suspension was stirred at ambient temperature for 48 hours. The reaction mixture was then diluted with ethyl acetate (200 mL) and washed with 1 N sodium hydroxide (200 mL) and brine (3X). Concentration of the organic phase afforded the desired aryl sulfide (5.2 grams, 90%).

Part B: To a solution of the ethyl ester of part A (5.1 g, 11.4 mmol) in ethanol (90 mL) and water (30 mL) was added sodium hydroxide (5.0 g, 125 mmol), and the mixture was heated to 65 degrees Celsius for 16 hours. Organics were removed *in vacuo*

and the resulting aqueous mixture was acidified with 2 N HCl to pH=3-4. Solid sodium chloride was added and the mixture was extracted with ethyl acetate. The combined organic extracts were washed with brine and dried with magnesium sulfate. Removal of the solvent afforded the desired carboxylic acid (4.5 g, 94%).

Part C: To a solution of the carboxylic acid of part B (4.5 g, 11.0 mmol) in N,N-dimethylformamide (50 mL) were added 4-methylmorpholine (1.62 g, 16.0 mmol), N-hydroxybenzotriazole (1.73 g, 12.8 mmol), and 1-[3-(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (2.87 g, 14.9 mmol) followed by O-(tetrahydro-2H-pyran-2-yl)hydroxylamine (2.39 g, 16.0 mmol). After stirring for 16 hours at ambient temperature, the reaction mixture was concentrated to a residue that was dissolved in ethyl acetate (200 mL) and washed with water and brine. Concentration and purification by chromatography on silica gel afforded the protected hydroxamate derivative that was used directly in the next step.

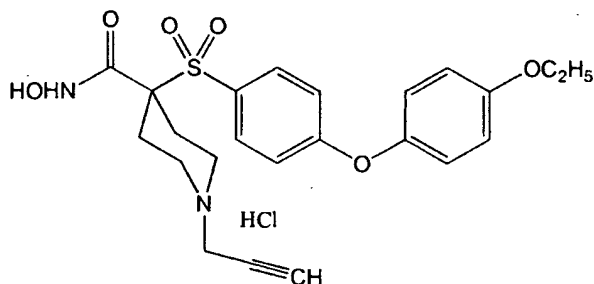
Part D: Hydrogen chloride gas was bubbled for 10 minutes through an ice bath-cooled solution of the protected hydroxamate of part C in ethyl acetate (30 mL). The mixture was then allowed to stand at ambient temperature for 2 hours after which time the solvent was removed *in vacuo*. Fresh ethyl acetate (30 mL) was added and then removed *in vacuo*, and this procedure was repeated. Ethyl acetate (50 mL) was then added and the solid was collected by filtration to afford a solid which was purified by reverse-phase chromatography eluting with acetonitrile/water

(gradient of 20/80 up to 100% acetonitrile) to afford the title compound (1.85 g, 35% for parts C and D). HRMS (ESI)  $MH^+$  calculated for  $C_{21}H_{21}FN_2O_4S_2$ : 449.1005, found 449.1023.

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Example 435: Preparation of 4-[[4-(4-ethoxyphenoxy)-phenyl]sulfonyl]-N-hydroxy-1-(2-propynyl)-4-piperidinecarboxamide, monohydrochloride

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Part A: To a solution of the product of Example 9, Part F (8.00 g, 22.6 mmol) in N,N-dimethylformamide (50 mL) were added 4-ethoxyphenol (9.38 g, 70 mmol) and cesium carbonate (22.8 g, 70 mmol), and the resulting suspension was heated at 75 degrees Celsius for 20 hours. The reaction mixture was then diluted with ethyl acetate (1000 mL) and washed with 1 N sodium hydroxide, water and brine. Concentration of the organic phase gave a residue that was purified by chromatography on silica gel, eluting with ethyl acetate/hexane (1:2), to afford the desired diaryl ether (10.5 grams, 99%).

Part B: To a solution of the ethyl ester of part A (10.5 g, 22.3 mmol) in ethanol (70 mL) and water (60 mL) was added sodium hydroxide (8.9 g, 222 mmol), and the mixture was heated to 65 degrees Celsius for 16 hours. Volatile organics were removed

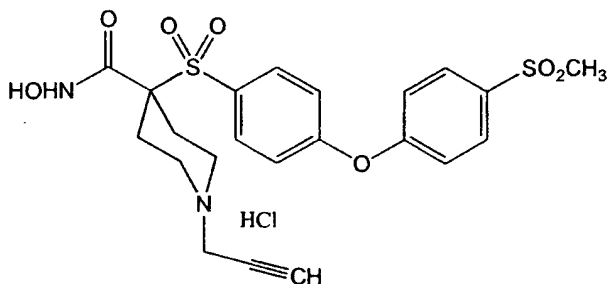
in vacuo and the resulting aqueous mixture was acidified with 2 N HCl to pH=3-4. Solid sodium chloride was added and the mixture was extracted with ethyl acetate. The combined organic extracts were  
5 washed with brine and dried with magnesium sulfate. Removal of the solvent afforded the desired carboxylic acid (10 g, 100%).

Part C: To a solution of the carboxylic acid of part B (10 g, 22.5 mmol) in N,N-  
10 dimethylformamide (50 mL) were added 4-methylmorpholine (3.42 g, 33.8 mmol), N-hydroxybenzotriazole (3.66 g, 27.1 mmol), and 1-[3-(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (6.05 g, 31.6 mmol) followed by O-  
15 (tetrahydro-2H-pyran-2-yl)hydroxylamine (5.05 g, 33.8 mmol). After stirring for 16 hours at ambient temperature, the reaction mixture was concentrated to a residue that was dissolved in ethyl acetate (200 mL) and washed with water and brine. Concentration  
20 and purification by chromatography on silica gel, eluting with ethyl acetate/hexane (1:1), afforded the protected hydroxamate derivative (6.5 g, 53%) which was used directly in the next step.

Part D: To a solution of the protected  
25 hydroxamate of part C in methanol/1,4-dioxane (1:3, 70 mL) was added 4 N HCl/1,4-dioxane (30 mL) and the solution was stirred at ambient temperature for 4 hours. The solvent was then removed in vacuo. Methanol (40 mL) was added and then removed in vacuo.  
30 Diethyl ether (100 mL) was added and the resulting solid was collected by filtration to afford the title compound (4.3 g, 72%). Analytical calculation for  $C_{23}H_{26}N_2O_6S \cdot HCl \cdot H_2O$ : C, 53.85; H, 5.70; N, 5.46; Cl,

6.91; S, 6.25. Found: C, 53.65; H, 5.62; N, 5.41; Cl, 6.86; S, 6.48. MS (ESI)  $MH^+$  calculated for  $C_{23}H_{26}N_2O_6S$ : 459, found 459.

- 5 Example 436: Preparation of N-hydroxy-4-[[4-[4-(methylsulfonyl)phenoxy]phenyl]-sulfonyl]-1-(2-propynyl)-4-piperidinecarboxamide, monohydrochloride



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Part A: To a solution of the product of Example 9, Part F (2.5 g, 6.4 mmol) in N,N-dimethylformamide (15 mL) were added 4-methylsulphonylphenol (3.5 g, 20.3 mmol) and cesium carbonate (8.7 g, 27 mmol), and the resulting suspension was heated at 90 degrees Celsius for 16 hours. The reaction mixture was then concentrated in vacuo. The residue was dissolved in ethyl acetate (500 mL) and washed with 1 N sodium hydroxide, water and brine. Concentration of the organic phase gave a residue which was purified by chromatography on silica gel eluting with ethyl acetate/hexane (1:1) to afford the desired aryl ether (2.5 grams, 77%).

25 Part B: To a solution of the ethyl ester of part A (2.5 g, 4.9 mmol) in ethanol (50 mL) and water (30 mL) was added sodium hydroxide (2.0 g, 49 mmol) and the mixture was heated to 65 degrees

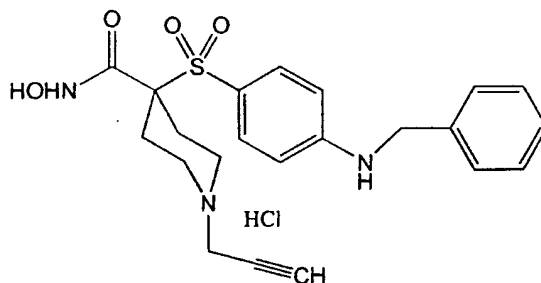
Celsius for 8 hours. The solvents were removed in vacuo. Water (50 mL) was added, the mixture was again concentrated in vacuo and the resulting mixture was acidified with 2 N HCl to pH=4-5. The solid precipitate was collected by filtration to afford the desired carboxylic acid (1.57 g, 67%).

Part C: To a solution of the carboxylic acid of part B (1.57 g, 3.3 mmol) in N,N-dimethylformamide (15 mL) were added 4-methylmorpholine (0.5 g, 4.9 mmol), N-hydroxybenzotriazole (0.53 g, 3.9 mmol), and 1-[3-(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (0.88 g, 4.6 mmol) followed by O-(tetrahydro-2H-pyran-2-yl)hydroxylamine (0.74, 4.9 mmol). After stirring for 16 hours at ambient temperature, the reaction mixture was concentrated to a residue that was dissolved in ethyl acetate (200 mL) and washed with water and brine. Concentration and purification by chromatography on silica gel, eluting with ethyl acetate/hexane, afforded the protected hydroxamate derivative (1.5 g, 79%), which was used directly in the next step.

Part D: To a solution of the protected hydroxamate of part C (1.5 g, 2.60 mmol) in methanol/1,4-dioxane (1:3, 40 mL) was added 4 N HCl/1,4-dioxane (10 mL), and the solution was stirred at ambient temperature for 3 hours. The solvent was then removed in vacuo. Methanol (30 mL) was added and then removed in vacuo. Diethyl ether (100 mL) was added and the resulting solid was collected by filtration to afford the title compound (1.35 g, 98%). Analytical calculated for  $C_{22}H_{24}N_2O_7S_2 \cdot HCl$ : C, 49.95; H, 4.76; N, 5.30; Cl, 6.70; S, 12.12. Found:

C, 49.78; H, 4.56; N, 5.25; Cl, 6.98; S, 11.98. HRMS (ESI) MH<sub>+</sub> calculated for C<sub>22</sub>H<sub>24</sub>N<sub>2</sub>O<sub>7</sub>S<sub>2</sub>: 493.1103, found 493.1116.

- 5 Example 437: Preparation of N-hydroxy-4-[[4-  
[(phenylmethyl)amino]phenyl]sulfonyl]-  
1-(2-propynyl-4-piperidinecarboxamide,  
monohydrochloride



Part A: To a solution of the product of Example 9, Part F (2.5 g, 6.4 mmol) in N,N-dimethylformamide (30 mL) were added benzylamine (3.44 g, 32.1 mmol) and cesium carbonate (10.5 g, 32.3 mmol) and the resulting suspension was heated at 100 degrees Celsius for 16 hours. The reaction mixture was then concentrated in vacuo. The residue was dissolved in ethyl acetate (500 mL) and washed with water and brine and dried over magnesium sulfate. Concentration of the organic phase gave a residue that was purified by chromatography on silica gel, eluting with ethyl acetate/hexane (1:1), to afford the desired benzyl aniline derivative (2.5 grams, 88%).

25 Part B: To a solution of the ethyl ester of part A (2.5 g, 5.67 mmol) in ethanol (50 mL) and water (30 mL) was added sodium hydroxide (2.27 g, 56.7 mmol), and the mixture was heated to 65 degrees

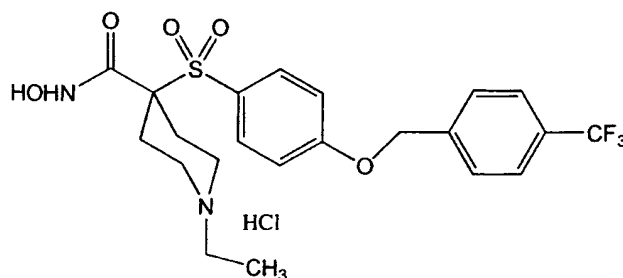
Celsius for 8 hours. The solvents were removed in vacuo. Water (50 mL) was added and the mixture was again concentrated in vacuo and the resulting mixture was acidified with 2 N HCl to pH = 4-5. The solid precipitate was collected by filtration and rinsed with diethyl ether to afford the desired carboxylic acid (2.3 g, 98%).

Part C: To a solution of the carboxylic acid of part B (2.3 g, 5.57 mmol) in N,N-dimethylformamide (15 mL) were added 4-methylmorpholine (0.85 g, 8.36 mmol), N-hydroxybenzotriazole (0.9 g, 6.69 mmol), and 1-[3-(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (1.5 g, 7.8 mmol) followed by O-(tetrahydro-2H-pyran-2-yl)hydroxylamine (1.25 g, 8.36 mmol). After stirring for 16 hours at ambient temperature, the reaction mixture was concentrated to a residue which was dissolved in ethyl acetate and washed with water and brine. Concentration and purification by chromatography on silica gel, eluting with ethyl acetate/hexane, afforded the protected hydroxamate derivative which was used directly in the next step.

Part D: Hydrogen chloride gas was bubbled for 10 minutes through an ice bath-cooled solution of the protected hydroxamate of part C in ethyl acetate (50 mL). The solvent was then removed in vacuo. Ethyl acetate (100 mL) was added and then removed in vacuo. Ethyl acetate (100 mL) was then added and the resulting solid was collected by filtration to afford the title compound (1.6 g, 62% for steps C and D). HRMS (ESI)  $MH^+$  calculated for  $C_{22}H_{25}N_3O_4S$ : 428.1644, found 428.1652.



Example 438: Preparation of 1-ethyl-N-hydroxy-4-[[4-  
[[4-[trifluoromethyl)phenyl]methoxy]-  
phenyl]sulfonyl]-4-piperidine-  
5 carboxamide, monohydrochloride



Part A: To a solution of the product of  
10 Example 429, Part B (1.0 g, 2.9 mmol) in N,N-  
dimethylacetamide (30 mL) were added 4-  
(trifluoromethyl)benzyl alcohol (1.53 g, 8.74 mmol)  
and cesium carbonate (2.85 g, 8.74 mmol), and the  
resulting suspension was heated at 95-100 degrees  
15 Celsius for 8 hours. The reaction mixture was then  
concentrated *in vacuo*. The residue was dissolved in  
ethyl acetate and washed with 1 N sodium hydroxide,  
water and brine. Concentration of the organic phase  
gave a residue that was purified by chromatography on  
20 silica gel eluting with ethyl acetate/hexane to  
afford the desired aryl ether (0.8 grams, 54%).

Part B: To a solution of the ethyl ester  
of part A (0.8 g, 1.5 mmol) in ethanol (50 mL) and  
water (50 mL) was added sodium hydroxide (1.0 g, 25  
25 mmol) and the mixture was heated to 60 degrees  
Celsius for 16 hours. The solvents were removed *in vacuo*.  
Water (50 mL) was added and the mixture was  
acidified with 2 N HCl to pH=4. The solid

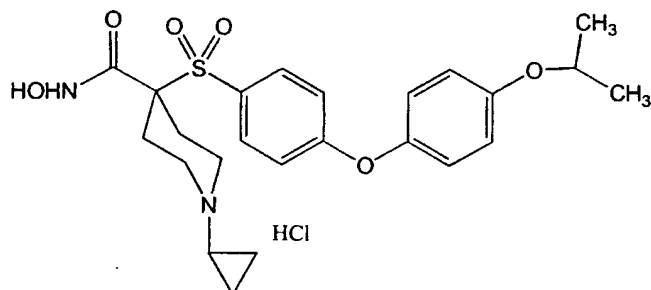
precipitate was collected by filtration to afford the desired carboxylic acid (0.75 g, 99%).

Part C: To a solution of the carboxylic acid of part B (0.75 g, 1.54 mmol) in N,N-dimethylformamide (10 mL) were added 4-methylmorpholine (0.47 g, 4.6 mmol), N-hydroxybenzotriazole (0.25 g, 1.85 mmol), and 1-[3-(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (0.41 g, 2.16 mmol) followed by O-(tetrahydro-2H-pyran-2-yl)hydroxylamine (0.35, 2.3 mmol). After stirring for 16 hours at ambient temperature, the reaction mixture was concentrated to a residue that was dissolved in ethyl acetate (200 mL) and washed with water and brine. Concentration and purification by chromatography on silica gel, eluting with ethyl acetate/hexane, afforded the protected hydroxamate derivative (250 mg, 57%).

Part D: To a solution of the protected hydroxamate of part C (250 mg, 0.43 mmol) in methanol/1,4-dioxane (1:3, 20 mL) was added 4 N HCl/1,4-dioxane (5 mL) and the solution was stirred at ambient temperature for 3 hours. The solvent was then removed *in vacuo*. An additional portion of ethyl acetate was added and then removed *in vacuo*. Diethyl ether (100 mL) was added and the resulting solid was collected by filtration to afford the title compound (190 mg, 82%). MS (CI)  $MH^+$  calculated for  $C_{22}H_{25}F_3N_2O_5S$ : 487, found 487.

Example 439: Preparation of 1-cyclopropyl-N-hydroxy-4-[[4-[4-(1-methylethoxy)phenoxy]-phenyl]-sulfonyl]-4-piperidinecarboxamide, monohydrochloride

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Part A: To a solution of the product of Example 398, Part A (2.49 g, 7.0 mmol) in N,N-dimethylacetamide (30 mL) were added 4-isopropoxyphenol, which may be prepared according to the procedure of *J. Indian Chem. Soc.* 73, 1996, 507-511, (1.28 g, 8.4 mmol) and cesium carbonate (5.48 g, 16.8 mmol), and the resulting suspension was heated at 60 degrees Celsius for 16 hours. The reaction mixture was then concentrated *in vacuo*. The residue was dissolved in ethyl acetate and washed with 1 N sodium hydroxide, water and brine. Concentration of the organic phase gave a residue which was purified by chromatography on silica gel, eluting with ethyl acetate/hexane, to afford the desired aryl ether (2.8 grams, 82%).

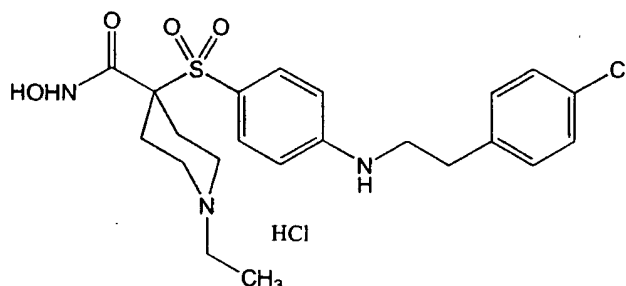
Part B: To a solution of the ethyl ester of part A (2.8 g, 5.7 mmol) in ethanol (50 mL) and water (50 mL) was added sodium hydroxide (2.3 g, 57 mmol) and the mixture was heated to 60 degrees Celsius for 16 hours. The solvents were removed *in*

vacuo. Water (50 mL) was added and the mixture was acidified with 2 N HCl to pH = 4. The solid precipitate was collected by filtration to afford the desired carboxylic acid (1.4 g, 53%).

5                   Part C: To a solution of the carboxylic acid of part B (1.4 g, 3.1 mmol) in N,N-dimethylformamide (15 mL) were added 4-methylmorpholine (0.92 g, 9.1 mmol), N-hydroxybenzotriazole (0.49 g, 3.66 mmol), and 1-[3-  
10 (dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (0.82 g, 4.26 mmol) followed by O-(tetrahydro-2H-pyran-2-yl)hydroxylamine (0.68 g, 4.5 mmol). After stirring for 16 hours at ambient temperature, the reaction mixture was concentrated to  
15 a residue that was dissolved in ethyl acetate and washed with water and brine. Concentration and purification by chromatography on silica gel, eluting with ethyl acetate/hexane, afforded the protected hydroxamate derivative which was used directly in the  
20 next step.

                  Part D: To a solution of the protected hydroxamate from part C in methanol/1,4-dioxane (1:3, 20 mL) was added 4 N HCl/1,4-dioxane (10 mL) and the solution was stirred at ambient temperature for 3  
25 hours. The solvent was then removed in vacuo. An additional portion of ethyl acetate was added and then removed in vacuo. Diethyl ether was added and the resulting solid was collected by filtration to afford the title compound (0.3 g, 19% for parts C and  
30 D together). Analytical calculation for  $C_{24}H_{30}N_2O_6S \cdot HCl$ : C, 56.41; H, 6.11; N, 5.48. Found: C, 56.04; H, 5.82; N, 5.44. MS (CI)  $MH^+$  calculated for  $C_{24}H_{30}N_2O_6S$ : 475, found 475.

Example 440: Preparation of 4-[[4-[[2-(4-chlorophenyl)-ethyl]amino]phenyl]-sulfonyl]-1-ethyl-N-hydroxy-4-piperidinecarboxamide, monohydrochloride



Part A: To a solution of the product of Example 429, Part B (1.0 g, 2.91 mmol) in N,N-dimethylacetamide (20 mL) were added 4-chlorophenethylamine (0.91 g, 5.8 mmol) and cesium carbonate (3.80 g, 11.6 mmol), and the resulting suspension was heated at 90 degrees Celsius for 24 hours. The reaction mixture was then concentrated in vacuo. The residue was dissolved in ethyl acetate and washed with 1 N sodium hydroxide, water and brine. Concentration of the organic phase gave a residue which was purified by chromatography on silica gel eluting with ethyl acetate/hexane to afford the desired aryl ether (0.8 grams, 58%).

Part B: To a solution of the ethyl ester of part A (0.8 g, 1.7 mmol) in ethanol (50 mL) and water (50 mL) was added sodium hydroxide (1.0 g, 25 mmol), and the mixture was heated to 60 degrees Celsius for 16 hours. The solvents were removed in vacuo. Water (50 mL) was added and the mixture was

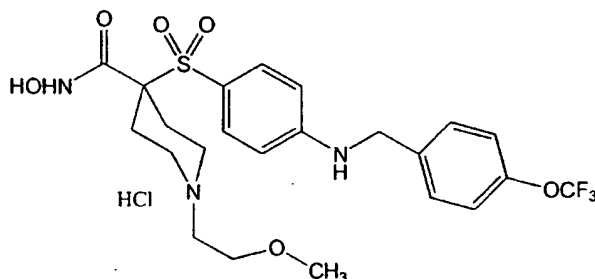
acidified with 2 N HCl to pH = 4. The solid precipitate was collected by filtration to afford the desired carboxylic acid (0.75 g, 92%).

Part C: To a solution of the carboxylic acid of Part B (0.75 g, 1.7 mmol) in N,N-dimethylformamide (20 mL) were added 4-methylmorpholine (0.51 g, 5.1 mmol), N-hydroxybenzotriazole (0.27 g, 2.0 mmol), and 1-[3-(dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (0.45 g, 2.3 mmol) followed by O-(tetrahydro-2H-pyran-2-yl)hydroxylamine (0.37 g, 2.5 mmol). After stirring for 16 hours at ambient temperature the reaction mixture was concentrated to a residue which was dissolved in ethyl acetate and washed with water and brine. Concentration and purification by chromatography on silica gel, eluting with ethyl acetate/hexane, afforded the protected hydroxamate derivative which was used directly in the next step.

Part D: To a solution of the protected hydroxamate from part C in methanol/1,4-dioxane was added 4 N HCl/1,4-dioxane (10 mL) and the solution was stirred at ambient temperature for 3 hours. The solvent was then removed *in vacuo*. An additional portion of ethyl acetate was added and then removed *in vacuo*. Diethyl ether was added and the resulting solid was collected by filtration to afford the title compound (30 mg, 4% for parts C and D together).

Example 441 Preparation of N-hydroxy-1-(2-methoxyethyl)-4-[[4-[[[4-(trifluoromethoxy)phenyl]methyl]amino]phenyl]-sulfonyl]-4-piperidinecarboxamide, monohydrochloride

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Part A: To a solution of ethyl-4-[(4-fluorophenylsulfonyl)]-1-(2-methoxyethyl)-4-piperidinecarboxylate (1.38g, 3.7 mmol) in N,N-dimethylformamide (20 mL) were added 4-(trifluoromethoxy)benzylamine (1.0 g, 5.2 mmol) and cesium carbonate (1.7 g, 5.2 mmol), and the resulting suspension was heated at 90 degrees Celsius for 24 hours. The reaction mixture was then concentrated in vacuo. The residue was dissolved in ethyl acetate and washed with 1 N sodium hydroxide, water and brine. Concentration of the organic phase gave a residue that was purified by chromatography on silica gel, eluting with ethyl acetate/hexane, to afford the desired trifluoromethoxy compound (0.6 grams, 30%).

Part B: To a solution of the ethyl ester of part A (0.6 g, 1.1 mmol) in ethanol (30 mL), water (30 mL) and tetrahydrofuran (15 mL) was added sodium hydroxide (0.44 g, 11 mmol), and the mixture was heated to 60 degrees Celsius for 16 hours. The solvents were removed in vacuo. Water (50 mL) was

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added and the mixture was acidified with 2 N HCl to pH=4. The solid precipitate was collected by filtration to afford the desired carboxylic acid (0.5 g, 88%).

5                   Part C: To a solution of the carboxylic acid of part B (0.50 g, 0.98 mmol) in N,N-dimethylformamide (10 mL) were added 4-methylmorpholine (0.15 g, 1.5 mmol), N-hydroxybenzotriazole (0.16 g, 1.2 mmol), and 1-[3-  
10 (dimethylamino)propyl]-3-ethylcarbodiimide hydrochloride (0.27 g, 1.4 mmol) followed by O-(tetrahydro-2H-pyran-2-yl)hydroxylamine (0.22 g, 1.5 mmol). After stirring for 16 hours at ambient temperature, the reaction mixture was concentrated to  
15 a residue that was dissolved in ethyl acetate and washed with water and brine. Concentration and purification by chromatography on silica gel, eluting with ethyl acetate/hexane, afforded the protected hydroxamate derivative (110 mg, 18%).

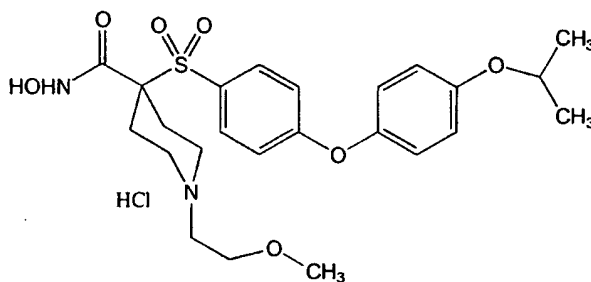
20                   Part D: To a solution of the protected hydroxamate from part C (110 mg, 0.18 mmol) in methanol/1,4-dioxane (1:4, 20 mL) was added 4 N HCl/1,4-dioxane (7 mL) and the solution was stirred at ambient temperature for 3 hours. The solvent was  
25 then removed *in vacuo*. An additional portion of methanol (20 mL) was added and then removed *in vacuo*. Diethyl ether was added and the resulting solid was collected by filtration to afford the title compound (30 mg, 31%). MS (ESI)  $MH^+$  calculated for  
30  $C_{23}H_{28}F_3N_3O_6S$ : 532, found 532.



-711-

Example 442: Preparation of N-hydroxy-4-[[4-[4-(1-methylethoxy)phenoxy]phenyl]sulfonyl]-1-(2-methoxyethyl)-4-piperidinecarboxamide, monohydrochloride

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Part A: To a solution of ethyl-4-[(4-fluorophenyl-sulfonyl)]-1-(2-methoxyethyl)-4-piperidinecarboxylate (2.0 g, 5.4 mmol) in N,N-dimethylformamide (20 mL) were added 4-isopropoxyphenol, which can be prepared according to the procedure of *J. Indian Chem. Soc.* **73**, 1996, 507-511, (1.63 g, 10.7 mmol) and cesium carbonate (7 g, 21.5 mmol), and the resulting suspension was heated at 60 degrees Celsius for 16 hours. The reaction mixture was then concentrated *in vacuo*. The residue was dissolved in ethyl acetate and washed with 1 N sodium hydroxide, water and brine and dried over magnesium sulfate. Concentration of the organic phase gave a residue that was purified by chromatography on silica gel, eluting with ethyl acetate/hexane, to afford the desired aryl ether (1.37 grams, 50%).

Part B: To a solution of the ethyl ester of part A (1.37 g, 2.7 mmol) in ethanol (30 mL) and water (30 mL) was added sodium hydroxide (1.08 g, 27

mmol), and the mixture was heated to 65 degrees Celsius for 16 hours. The solvents were then removed *in vacuo*. Water (50 mL) was added and the mixture was again concentrated *in vacuo* and the resulting mixture was acidified with 2 N HCl to pH = 4-5. The solid precipitate was collected by filtration and rinsed with diethyl ether to afford the desired carboxylic acid (1.25 g, 100%).

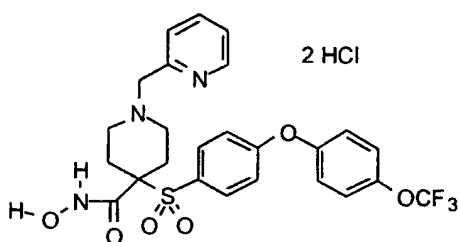
Part C: To a suspension of the carboxylic acid of part B (1.25 g, 2.7 mmol) in N,N-dimethylformamide (15 mL) were added 4-methylmorpholine (0.82 g, 8.1 mmol), O-(tetrahydro-2H-pyran-2-yl)hydroxylamine (0.61, 4.1 mmol) followed by bromo-tris-pyrrolidino-phosphonium hexafluorophosphate (PyBroP, 1.51 g, 3.3 mmol). After stirring for 16 hours at ambient temperature, the reaction mixture was concentrated to a residue that was dissolved in ethyl acetate and washed with water and brine. Concentration and purification by chromatography on silica, gel eluting with ethyl acetate/hexane, afforded the protected hydroxamate derivative (1.0 g, 63%).

Part D: Hydrogen chloride gas was bubbled for 5 minutes through an ice bath-cooled solution of the protected hydroxamate of part C (1.0 g, 1.7 mmol) in ethyl acetate (20 mL). After stirring at ambient temperature for 5 hours, the solvent was removed *in vacuo*. Ethyl acetate (30 mL) was added and then removed *in vacuo*. Ethyl acetate (30 mL) was again added and the resulting solid was collected by filtration to afford the title compound (0.5 g, 56%). Analytical calculation for  $C_{24}H_{32}N_2O_7S \cdot HCl \cdot 1.5H_2O$ : C, 51.84; H, 6.53; N, 5.04; Cl, 6.38; S, 5.77. Found:

-713-

C, 51.87; H, 6.12; N, 4.92; Cl, 6.38; S, 5.84. MS MH<sup>+</sup> calculated for C<sub>24</sub>H<sub>32</sub>N<sub>2</sub>O<sub>7</sub>S: 493, found 493.

5 Example 443: Preparation of N-Hydroxy-1-(2-pyridinylmethyl)-4-[4-(4-trifluoromethoxyphenoxy)phenyl]sulfonyl]-4-piperidinecarboxamide, dihydrochloride



Part A: The aryl flouride from Example 9, Part D (6.22 g, 15 mmol) was combined with powdered potassium carbonate (3.04 g, 22 mmol), 4-(trifluoromethoxy)phenol (3.92 g, 322 mmol), and N,N-dimethylforamide (7 mL), and the mixture was stirred at ninety degrees Celcius for sixteen hours. Additional 4-(trifluoromethoxy)-phenol (1 g) and potassium carbonate (800 mg) were added and the reaction was continued at one hundred and fifteen degrees Celsius for twenty additional hours. The mixture was diluted with water (100 mL) and extracted with ethyl acetate (100 mL, then 2 X 25 mL). The combined organic layers were dried using magnesium sulfate, concentrated, and chromatographed, affording the desired aryl ether as an oil (9.6 g, about quantitative).

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Part B: The aryl ether from part A (9.6 g, about 15 mmol) was dissolved in ethyl acetate (45

mL). A solution of HCl in dioxane (4N, 12 mL) was added, and the mixture was stirred at ambient temperature for three hours. Thin layer chromatography indicated incomplete deprotection.

5 Concentrated aqueous HCl (4 mL) was added and the reaction was heated to reflux with a heat gun several times. The solution was concentrated and was then azeotroped with acetonitrile to afford the desired piperidine hydrochloride salt as a foam (9.6 g).

10 Nuclear magnetic resonance spectroscopy indicated some contaminating 4-(trifluoromethoxy)phenol, which must have been carried through from part A.

The piperidine hydrochloride salt (6.0 g) was dissolved in ethyl acetate (125 mL) and washed

15 with aqueous sodium hydroxide (2 g NaOH in 50 mL water). The organic layer was dried with magnesium sulfate and filtered through a pad of silica gel. The phenol contaminant was eluted. The desired piperidine was then freed from the filter cake by

20 elution with methanol containing 1% aqueous ammonium hydroxide (circa 100 mL). The filtrate was concentrated and azeotroped with acetonitrile to yield 3.3 g (7.3 mmol).

Part C: The piperidine from Part B (1.24 g,

25 2.7 mmol) was combined with powdered potassium carbonate (828 mg, 6.0 mmol), 2-picoyl hydrochloride (492 mg, 3.0 mmol), and N,N-dimethylformamide (3 mL), and the mixture was stirred at ambient temperature for two hours, then heated at fifty degrees Celsius

30 for two additional hours. The mixture was diluted with water (40 mL) and extracted with ethyl acetate (150 mL, then 50 mL). The combined organic layers were dried using magnesium sulfate, concentrated, and

chromatographed, affording the desired ester as an oil (1.13 g, 74%).

Part D: The ester from part C (1.1 g, 2.0 mmol) was combined with ethanol (6 mL), water (2 mL),  
5 and potassium hydroxide (0.90 g, 16 mmol). The mixture was brought to reflux and heated for four and one-half hours. The solution was then cooled to zero degrees Celsius and acidified using concentrated aqueous hydrogen chloride. The solvent was removed,  
10 and the resulting solids were dried by azeotropeing with acetonitrile. A vacuum was applied until constant weight was achieved.

The crude acid hydrochloride salt was stirred with N-methylmorpholine (about 0.5 mL), 1-  
15 hydroxybenzotriazole (0.405 g, 3 mmol), O-tetrahydropyranyl hydroxylamine (0.35 g, 3.0 mmol), and N,N-dimethylformamide (9 mL). After ten minutes, 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride (0.57 g, 3.0 mmol) was added, and the  
20 mixture was stirred overnight. The reaction was then diluted with half-saturated aqueous sodium bicarbonate (50 mL), and extracted with ethyl acetate (100 mL, then 25 mL). The combined organic layers were dried over magnesium sulfate, concentrated, and  
25 chromatographed (9:1 ethyl acetate: methanol) to afford the desired tetrahydropyranyl-protected hydroxamate as a yellow oil (1.20 g, 95%).

Part E: The tetrahydropyranyl-protected hydroxamate (1.20 g, 1.90 mmol) was diluted with  
30 methanol (9 mL). Acetyl chloride (0.78 mL, 11 mmol) was added over two minutes. The reaction was stirred for 2 hours at ambient temperature, then concentrated to afford the desired dihydrochloride salt (1.20 g,

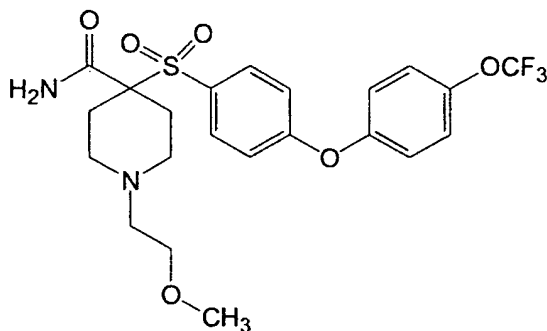
quantitative yield) as a white crystalline solid.

Analytical calculation for  $C_{25}H_{24}F_3N_3O_6S \cdot 1.1/3 H_2O$ : C, 47.58; H, 4.07; N, 6.66. Found: C, 47.31; H, 4.14; N, 6.80.

5

Example 444: Preparation of 1-(2-methoxyethyl)-  
4-[[4-[4-(trifluoromethoxy)  
phenoxy]phenyl]sulfonyl]-  
4-piperidinecarboxamide

10



Part A: To a solution of the product of Example 9D (30 g, 161 mmol) in dichloromethane (50 mL) cooled to zero degrees Celsius was added trifluoroacetic acid (25 mL) and the solution was stirred at ambient temperature for 1 hour. Concentration *in vacuo* provided the amine trifluoroacetate salt as a light yellow gel. To the solution of the trifluoroacetate salt and  $K_2CO_3$  (3.6 g, 26 mmol) in *N,N*-dimethylformamide (50 mL) cooled to zero degrees Celsius was added 2-bromoethyl methyl ether (19 mL, 201 mmol) and solution was stirred at ambient temperature for 36 hours. Then *N,N*-dimethylformamide was evaporated under high vacuum and the residue was diluted with ethyl acetate. The organic layer was washed with water and dried over

MgSO<sub>4</sub>. Concentration *in vacuo* provided the methoxyethyl amine as a light yellow gel (26.03 g, 86.8%).

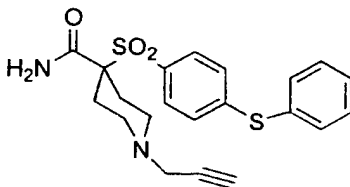
Part B: To a solution of the methoxyethyl  
5 amine (6.0 g, 16.0 mmol) of part A and powdered K<sub>2</sub>CO<sub>3</sub>  
(4.44 g, 32 mmol) in N,N-dimethylformamide (30 mL)  
was added 4-(trifluoromethoxy)phenol (5.72 g, 32  
mmol) at ambient temperature and the solution was  
heated to ninety degrees Celsius for 25 hours. The  
10 solution was concentrated under high vacuum and the  
residue was dissolved in ethyl acetate. The organic  
layer was washed with 1N NaOH, H<sub>2</sub>O and dried over  
MgSO<sub>4</sub>. Chromatography on silica eluting with ethyl  
acetate/hexane provided trifluoromethoxy  
15 phenoxyphenyl sulfone as a light yellow gel (7.81 g,  
91.5%).

Part C: To a solution of trifluoromethoxy  
phenoxyphenyl sulfone of part B (7.81 g, 14.7 mmol)  
in ethanol (14 mL) and tetrahydrofuran (14 mL) was  
20 added NaOH (5.88 g, 147 mmol) in H<sub>2</sub>O (28 mL) from an  
addition funnel at ambient temperature. The solution  
was then heated to sixty degrees Celsius for 18  
hours. The solution was concentrated *in vacuo* and  
diluted with water. The aqueous layer was extracted  
25 with ether and acidified to pH = 2. Vacuum  
filtration of the white precipitation provided the  
carboxylic acid as a white solid (5.64 g, 73.3%).

Part D: To a suspension of the carboxylic  
acid of part C (200 mg, 0.397 mmol) in methylene  
30 chloride (4 mL) was added oxalyl chloride (101 mg,  
0.80 mmol). After 15 minutes at ambient temperature  
the volatiles were removed under vacuum. The solid  
residue was resuspended in methylene chloride (4 mL)

and gaseous ammonia was bubbled through the suspension. Triethylamine (81 mg, 0.80 mmol) was added and the stream of ammonia gas through the reaction was continued for 1 minute. Concentration  
5 afforded a solid which was chromatographed (reverse phase C<sub>18</sub> silica eluting with a gradient of 30% acetonitrile/water to 100% acetonitrile) to afford the desired primary amide as a colorless powder (6 mg, 3 mg). MS MH<sup>+</sup> calculated for C<sub>22</sub>H<sub>25</sub>N<sub>2</sub> F<sub>3</sub>O<sub>6</sub>S: 503,  
10 found 503. HRMS M<sup>+</sup> calculated for C<sub>22</sub>H<sub>25</sub>N<sub>2</sub> F<sub>3</sub>O<sub>6</sub>S: 503.1464, found 503.1472.

Example 445: Preparation of 4-[(4-phenylthiophenyl)sulfonyl]-1-(2-propynyl)-  
15 4-piperidinecarboxamide



A mixture of the acid from Example 9H (1.29 g, 2.85 mMol), N-hydroxybenzotriazole (1.15 g, 8.54 mMol), 4-methylmorpholine (0.94 mL, 14 mMol), concentrated NH<sub>4</sub>OH (3 mL), and 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride (1.64 g, 8.54 mMol) in DMF (25 mL) was  
20 stirred at ambient temperature for 20 hours. The mixture was concentrated in vacuo, diluted with water, and extracted with ethyl acetate. The organic layer was washed with saturated NaHCO<sub>3</sub>, water, and brine, dried over magnesium sulfate, and concentrated



in vacuo. Chromatography (on silica, MeOH/CHCl<sub>3</sub>) afford the title amide as a white solid (0.143 g, 12%). Analytical calculation for C<sub>21</sub>H<sub>22</sub>N<sub>2</sub>O<sub>3</sub>S<sub>2</sub>: C, 60.84; H, 5.35; N, 6.76; S, 15.47. Found: C, 60.74; 5 H, 5.31; N, 6.74; S, 15.43.

Example 446: In Vitro Metalloprotease Inhibition

The compounds prepared in the manner described in the Examples above were assayed for 10 activity by an *in vitro* assay. Following the procedures of Knight et al., *FEBS Lett.* 296(3):263 (1992). Briefly, 4-aminophenylmercuric acetate (APMA) or trypsin-activated MMPs were incubated with various concentrations of the inhibitor compound at 15 room temperature for 5 minutes.

More specifically, recombinant human MMP-13, MMP-1, MMP-2 and MMP-9 enzymes were prepared in laboratories of the assignee following usual laboratory procedures. MMP-13 from a full length 20 cDNA clone was expressed as a proenzyme using a baculovirus as discussed in V.A. Luckow, Insect Cell Expression Technology, pages 183-218, in Protein Engineering: Principles and Practice, J.L.Cleland et al eds., Wiley-Liss, Inc., (1996). See, also, Luckow 25 et al., *J. Virol.*, 67:4566-4579 (1993); O'Reilly et al., Baculovirus Expression Vectors: A Laboratory Manual, W.H. Freeman and Company, New York, (1992); and King et al., The Baculovirus Expression System: A Laboratory Guide, Chapman & Hall, London (1992) for 30 further details on use of baculovirus expression systems. The expressed enzyme was purified first over a heparin agarose column and then over a

chelating zinc chloride column. The proenzyme was activated by APMA for use in the assay.

MMP-1 expressed in transfected HT-1080 cells was provided by Dr. Harold Welgus of Washington University, St. Louis, MO. The enzyme was also activated using APMA and was then purified over a hydroxamic acid column. Dr. Welgus also provided transfected HT-1080 cells that expressed MMP-9. Transfected cells that expressed MMP-2 were provided by Dr. Gregory Goldberg, also of Washington University. Studies carried out using MMP-2 in the presence of 0.02% 2-mercaptoethanol are shown in the table below with an asterisk. Further specifics for preparation and use of these enzymes can be found in the scientific literature describing these enzymes. See, for example, Enzyme Nomenclature, Academic Press, San Diego, Ca (1992) and the citations therein, and Frije et al., J. Biol. Chem., 26(24): 16766-16773 (1994). The enzyme substrate is a methoxycoumarin-containing polypeptide having the following sequence:

MCA-ProLeuGlyLeuDpaAlaArgNH<sub>2</sub>, wherein MCA is methoxycoumarin and Dpa is 3-(2,4-dinitrophenyl)-L-2,3-diaminopropionyl alanine. This substrate is commercially available from Baychem as product M-1895.

The buffer used for assays contained 100 mM Tris-HCl, 100 mM NaCl, 10 mM CaCl<sub>2</sub> and 0.05 percent polyethyleneglycol (23) lauryl ether at a pH value of 7.5. Assays were carried out at room temperature, and dimethyl sulfoxide (DMSO) at a final

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concentration of 1 percent was used to dissolve inhibitor compound.

The assayed inhibitor compound in DMSO/buffer solution was compared to an equal amount of DMSO/buffer with no inhibitor as control using Microfluor™ White Plates (Dynatech). The inhibitor or control solution was maintained in the plate for 10 minutes and the substrate was added to provide a final concentration of 4  $\mu$ M.

In the absence of inhibitor activity, a fluorogenic peptide was cleaved at the gly-leu peptide bond, separating the highly fluorogenic peptide from a 2,4-dinitrophenyl quencher, resulting in an increase of fluorescence intensity (excitation at 328 nm/emission at 415 nm). Inhibition was measured as a reduction in fluorescent intensity as a function of inhibitor concentration, using a Perkin Elmer L550 plate reader. The IC<sub>50</sub> values were calculated from those values. The results are set forth in the Inhibition Tables A and B below, reported in terms of IC<sub>50</sub> to three significant figures, where appropriate.

Inhibition Table A (nM)

25

Example	MMP-13	MMP-2	MMP-1	MMP-9
Number	IC <sub>50</sub> (nM)	IC <sub>50</sub> (nM)	IC <sub>50</sub> (nM)	IC <sub>50</sub> (nM)
1	5.1	2.6	6600	31.6
2	0.25	0.1	220	1.4
3	0.3	0.2	1140	
4	0.35	0.23	1090	5
5	4800	1800	>10000	

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6	0.25	0.15	327	
7	37.2	1.8	>10000	235
8	24.1	4	>10000	290
9	0.5	0.2	9000	1.5
10	0.4	0.2	1600	0.3
11	6	4.4	>10000	
12	<0.1	<0.1	464	
13	0.6	0.4	>10000	8
14	0.1	<0.1	464	
15	0.4	0.2	3600	0.2
16	2.4	100	>10000	2500
17	0.3	0.2	400	0.3
18	0.5	0.3	800	
19	9	13.9	>10000	
20	1.7	23.5	10000	
21	0.6	1.3	>10000	
22	1.2	0.9	>10000	
23	0.2	<0.1	2275	
24	0.4	1	>10000	3.7
25	3	2.6	>10000	
26	0.5	0.2	7700	7
27	0.45	0.4	>10000	4
28	<0.1	<0.1	770	
29	0.3	0.15	>10,000	

Inhibition Table B (nM)

Example	MMP-1	MMP-2	MMP-9	MMP-13
Number	IC <sub>50</sub> (nM)	IC <sub>50</sub> (nM)	IC <sub>50</sub> (nM)	IC <sub>50</sub> (nM)
30	350	0.1	0.3	0.1
31	370	<0.1		0.2

32	>10000	0.1	2.5	0.2
33	>10000	0.5	9.4	0.8
34	>10000	1.1		1.2
35	>10000	0.3	3	0.5
36	7300	0.4	8	0.6
37	1000	0.2		0.3
38	>10000	20	135	22
39	>10000	230		24.5
40	4400	0.4	2.4	1.9
41	1200	0.15		0.2
42	2200	0.2	1.3	0.4
43	7000	0.4		0.8
44a	>10000	<0.1		0.2
44b	>10000	8000		>10000
45	8800	2.5		1.7
46	710000	—	—	710000
47a	>10000	7		14.6
47b	>10000	3000		3100
48	210	0.2		0.25
49	>10000	76.9		90.0
51	5500	0.7		1.3
52	>10000	2.7		5.9
53	>10000	0.3	92	1.5
54	>10000	60		120
55	1200	0.1		0.3
56	1500	<0.1		0.15
57	1200	<0.1		0.2
58	>10000	83		30
59	>10000	130		180
60	>10000	64		147
61	>10000	1500		2000
62	>10000	>10000		>10000

63	>10000	18.1	530	1.5
64	1470	<0.1		0.15
65	8000	0.6	4.4	0.7
66	>10000	4590		36000
67	1600	239		268
68	>10000	5.3	130	6
69	1140	<0.1	0.2	<0.1
70	1500	0.2	7.3	0.8
71	3600	0.35	5	0.8
72	2100	<0.1		0.3
73	1140	<0.1	0.2	<0.1
74	>10000	130		480
75	>10000	60		900
78	>10000	6	50	10
79	>10000	1		1.7
80	3000	0.1	1.8	0.2
81	3300	0.1		0.3
82	4000	0.1		0.3
83	8000	1.2	5	1.5
84	8000	1.8		2.5
85	500	<0.1	0.4	<0.1
86	>10000	2.5		3.5
87	7200	0.8	13.9	0.35
88	1100	0.2	0.5	0.2
89	1200	0.15	0.4	0.25
90	1200	0.1		0.1
91	1800	1.5	40	2.1
92	>10000	1800		2430
93	8000	0.4	3.5	0.7
94	268	<0.1	0.4	<0.1
95	>10000	1	3.6	0.5
96	5000	0.2	1.3	0.3

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97	4000	8.2		16.7
98	>10000	37		23.4
99	>10000	0.4		1
100	435	<0.1	0.3	0.15
101	1800	0.3	2.9	0.45
102	2000	<0.1		0.2
103	>10000	0.8	10	0.7
104	>10000	1.5	42.8	0.65
105	>10000	3500	114	0.85
106	>10000	27.1		12.1
107	>10000	12.1		6
108	2000	0.4		0.4
109	500	0.1	0.7	0.3
110	2700	0.4	10	0.5
111	3700	0.5		1.3
112	1000	7		3.2
113	>10000	0.9		4
114	3000	0.65	31.6	0.4
115	4500	0.3	31.6	0.6
116	2350	2	15.3	5.5
117	3700	0.6	45.4	4.8
118	2850	0.3	50	0.8
119	>10000	1.5	30	1.7
120	4000	0.4		0.4
121	1200	<0.1		0.2
122	600	0.1		0.15
123	3600	1.8	27.8	1.8
124	1000	0.5		1.1
125	>10000	0.4	7	0.5
126	8000	11.3		10
127	>10000	37		40
128	>10000	23.8		20

129	>10000	>100	1000
130	>10000	57.7	45.9
131	>10000	650	10
132	>10000	420	
133	>10000	90	27
134	9000	29	4
135	>10000	500	65
136	>10000	445	40
137	>10000	300	34.7
138	>10000	>100	>100
139	>10000	1000	25.4
140	>10000	1000	60
141	>10000	>100	>100
142	>10000	600	70
143	>10000	900	23.9
144	>10000	800	30.7
145	>10000	>100	>100
146	>10000	650	32.6
147	>10000	2700	31
148	>10000	2400	31
149	>10000	1600	15.5
150	>10000	1300	14.5
151	>10000	1500	35
152	>10000	2400	16.5
153	>10000	2700	13.5
154	>10000	1600	27
155	>10000	>1000	>100
156	>10000	3300	27.8
157	>10000	6000	90
158	>10000	5000	80
159	>10000	2500	15.6
160	>10000	4700	33.7



161	>10000	>1000	>100
162	>10000	>1000	>100
163	>10000	4000	77.4
164	>10000	1750	20
165	>10000	330	13.6
166	>10000	>1000	>100
167	>10000	>1000	>100
168	>10000	>1000	>100
169	10000	>1000	>100
170	10000	>1000	>100
171	>10000	>1000	>100
172	>10000	>1000	>100
173	>10000	>1000	>100
174	8000	900	>100
175	10000	>1000	>100
176	>10000	400	25
177	>10000	400	21
178	>10000	540	>100
179	>10000	440	100
180	5000	128	4
181	10000	121	6.1
182	>10000	240	4
183	>10000	288	40
184	>10000	94	7
185	>10000	210	17.5
186	>10000	120	10
187	>10000	290	12.1
188	>10000	350	9.4
189	3700	94	8
190	>10000	220	10.6
191	>10000	350	4
192	>10000	330	10

193	>10000	390	6
194	10000	165	8
195	10000	100	14.5
196	>10000	240	25
197	7000	145	8
198	>10000	270	14.5
199	>10000	155	1.4
200	>10000	24	17.5
201	>10000	22.4	13.6
202	>10000	54	9.15
203	8500	31	30
204	>10000	25	27.1
205	7300	12.7	2
206	>10000	>10.0	20
207	>10000	30.6	28
208	>10000	27	27
209	>10000	19	20
210	>10000	27	20
211	>10000	33	24
212	>10000	33	20
213	310	<1.0	<1.0
214	1100	<1.0	<1.0
215	250	<1.0	<1.0
216	1000	<1	<1.0
217	600	<1.0	<1.0
218	>10000	<1.0	<1.0
219	>10000	<1.0	<1.0
220	145	<1.0	<1.0
221	1600	<1.0	<1.0
222	100	<1.0	<1.0
223	1100	<1.0	<1.0
224	>10000	18.1	16.7

225	>10000	54	70
226	>10000	18.6	6
227	>10000	<1	<1
228	600	<1.0	<1.0
229	>10000	<1	<1
230	>10000	>100	>100
231	650	<1.0	<1.0
232	<100	<1.0	<1.0
444	>10000	8.5	22.7
445	>10000	6000	5500

Example 447: In Vivo Angiogenesis Assay

The study of angiogenesis depends on a  
 5 reliable and reproducible model for the stimulation  
 and inhibition of a neovascular response. The  
 corneal micropocket assay provides such a model of  
 angiogenesis in the cornea of a mouse. See, *A Model  
 of Angiogenesis in the Mouse Cornea*; Kenyon, BM,  
 10 et al., *Investigative Ophthalmology & Visual Science*,  
 July 1996, Vol. 37, No. 8.

In this assay, uniformly sized Hydrion™  
 pellets containing bFGF and sucralfate were prepared  
 and surgically implanted into the stroma mouse cornea  
 15 adjacent to the temporal limbus. The pellets were  
 formed by making a suspension of 20 µL sterile saline  
 containing 10 µg recombinant bFGF, 10 mg of  
 sucralfate and 10 µL of 12 percent Hydrion™ in  
 ethanol. The slurry was then deposited on a 10 x 10  
 20 mm piece of sterile nylon mesh. After drying, the  
 nylon fibers of the mesh were separated to release  
 the pellets.

The corneal pocket is made by anesthetizing a 7 week old C57Bl/6 female mouse, then proptosing the eye with a jeweler's forceps. Using a dissecting microscope, a central, intrastromal linear keratotomy of approximately 0.6 mm in length is performed with a #15 surgical blade, parallel to the insertion of the lateral rectus muscle. Using a modified cataract knife, a lamellar micropocket is dissected toward the temporal limbus. The pocket is extended to within 1.0 mm of the temporal limbus. A single pellet was placed on the corneal surface at the base of the pocket with a jeweler's forceps. The pellet was then advanced to the temporal end of the pocket. Antibiotic ointment was then applied to the eye.

Mice were dosed on a daily basis for the duration of the assay. Dosing of the animals was based on bioavailability and overall potency of the compound. an exemplary dose was 10 or 50 mg/kg (mpk) bid, po. Neovascularization of the corneal stroma begins at about day three and was permitted to continue under the influence of the assayed compound until day five. At day five, the degree of angiogenic inhibition was scored by viewing the neovascular progression with a slit lamp microscope.

The mice were anesthetized and the studied eye was once again proptosed. The maximum vessel length of neovascularization, extending from the limbal vascular plexus toward the pellet was measured. In addition, the contiguous circumferential zone of neovascularization was measured as clock hours, where 30 degrees of arc equals one clock hour. The area of angiogenesis was calculated as follows.

$$area = \frac{(0.4 \times clock\ hours \times 3.14 \times vessel\ length\ (in\ mm))}{2}$$

Five to six mice were utilized for each compound in each study. The studied mice were thereafter compared to control mice and the difference in the area of neovascularization was recorded as an averaged value. Each group of mice so studied constitutes an "n" value of one, so that "n" values greater than one represent multiple studies whose averaged result is provided in the table. A contemplated compound typically exhibits about 25 to about 75 percent inhibition, whereas the vehicle control exhibits zero percent inhibition.

Data for four compounds of the above examples are provided below at dosages of 10 and 50 mpk.

#### Inhibition of Angiogenesis

<u>Example</u>	<u>Dosage</u>	
	<u>10 mpk</u>	<u>50 mpk</u>
Marimastat	--	48 (n=6)
4	18 (n=3)	41 (n=6)
9	50 (n=2)	46 (n=3)
10	47 (n=1)	54 (n=2)
24	53 (n=1)	78 (n=1)

Example 448: In Vivo PC-3 Tumor Reduction

PC-3 human pancreatic cancer cells (ATCC CRL 1435) were grown to 90% confluence in F12/MEM (Gibco) containing 7% FBS (Gibco). Cells were mechanically harvested using a rubber scraper, and then washed twice with cold medium. The resulting cells were resuspended in cold medium with 30% matrigel (Collaborative Research) and the cell-containing medium was maintained on ice until used.

Balb/c nu/nu mice at 7-9 weeks of age were anesthetized with avertin [2,2,2-tribromethanol/t-amyl alcohol (1 g/1 mL) diluted 1:60 into phosphate-buffered saline] and  $3-5 \times 10^6$  of the above cells in 0.2 mL of medium were injected into the left flank of each mouse. Cells were injected in the morning, whereas dosing with an inhibitor began at 6 PM. The animals were gavaged BID from day zero (cell injection day) to day 25-30, at which time the animals were euthanized and tumors weighed.

Compounds were dosed at 10 mg/mL in 0.5% methylcellulose/0.1% polysorbate 80 to provide a 50 mg/kg (mpk) dose twice each day, or diluted to provide a 10 mg/kg (mpk) dose twice each day. Tumor measurements began on day 7 and continued every third or fourth day until completion of the study. Groups of ten mice were used in each study and nine to ten survived. Each group of mice so studied constitutes an "n" value of one, so that "n" values greater than one represent multiple studies whose averaged result is provided in the table. The results of this study for several of the before discussed compounds are shown below as average reductions in tumor weight.

## Average Percentage Reduction

In Tumor WeightDosage

<u>Example</u>	<u>10 mpk</u>	<u>50 mpk</u>
Marimastat	<5	39 (n=2)
4	33 (n=2)	43 (n=2)
9	40 (n=1)	60 (n=1)
10	nt	59 (n=1)

10

Example 449: Tumor Necrosis Factor Assays

## Cell Culture.

15

The cells used in the assay are the human monocytic line U-937 (ATCC CRL-1593). The cells are grown in RPMI w/10% FCS and PSG supplement (R-10) and are not permitted to overgrow. The assay is carried out as follows:

20

1. Count, then harvest cells by centrifugation. Resuspend the pellet in R-10 supplement to a concentration of  $1.540 \times 10^6$  cells/mL.

25

2. Add test compound in 65 uL R-10 to the appropriate wells of a 96-well flat bottom tissue culture plate. The initial dilution from a DMSO stock (100 mM compound) provides a 400 uM solution, from which five additional three-fold serial dilutions are made. Each dilution of 65 ul (in triplicate) yields final compound test concentrations of 100  $\mu$ M, 33.3  $\mu$ M, 11.1  $\mu$ M, 3.7  $\mu$ M, 1.2  $\mu$ M and 0.4  $\mu$ M.

30

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3. The counted, washed and resuspended cells (200,000 cells/well) in 130  $\mu$ L are added to the wells.

4. Incubation is for 45 minutes to one hour at 37°C in 5% CO<sub>2</sub> in a water saturated container.

5. R-10 (65  $\mu$ L) containing 160 ng/mL PMA (Sigma) is added to each well.

6. The test system is incubated at 37°C in 5% CO<sub>2</sub> overnight (18-20 hours) under 100% humidity.

7. Supernatant, 150  $\mu$ L, is carefully removed from each well for use in the ELISA assay.

8. For toxicity, a 50  $\mu$ L aliquot of working solution containing 5 mL R-10, 5 mL MTS solution [CellTiter 96 Aqueous One Solution Cell Proliferation Assay Cat.#G358/0,1 (Promega Biotech)] and 250  $\mu$ L PMS solution are added to each well containing the remaining supernatant and cells and the cells incubated at 37°C in 5% CO<sub>2</sub> until the color develops. The system is excited at 570 nm and read at 630 nm.

20

#### TNF Receptor II ELISA Assay

1. Plate 100  $\mu$ L/well 2  $\mu$ g/mL mouse anti-human TNF $\alpha$  antibody (R&D Systems #MAB226) in 1 x PBS (pH 7.1, Gibco) on NUNC-Immuno Maxisorb plate. Incubate the plate at 4°C overnight (about 18-20 hours).

2. Wash the plate with PBS-Tween (1 x PBS w/ 0.05% Tween).

3. Add 200  $\mu$ L 5% BSA in PBS and block at 37°C in a water saturated atmosphere for 2 hours.

4. Wash the plate with PBS-Tween.

30



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5. Add sample and controls (100  $\mu$ L of each) to each well. The standards are 0, 50, 100, 200, 300 and 500 pg recombinant human TNFrII (R&D Systems #226-B2) in 100  $\mu$ L 0.5% BSA in PBS. The assay is linear to between 400-500 pg of standard.

6. Incubate at 37°C in a saturated atmosphere for 1.5 hours.

7. Wash the plate with PBS-Tween.

8. Add 100  $\mu$ L goat anti-human TNFrII polyclonal (1.5  $\mu$ g/mL R&D Systems #AB226-PB in 0.5% BSA in PBS).

9. Incubate at 37°C in a saturated atmosphere for 1 hour.

10. Wash the plate with PBS-Tween.

11. Add 100  $\mu$ L anti-goat IgG-peroxidase (1:50,000 in 0.5% BSA in PBS, Sigma #A5420).

11. Incubate at 37°C in a saturated atmosphere for 1 hour.

12. Wash the plate with PBS-Tween.

13. Add 10  $\mu$ L KPL TMB developer, develop at room temperature (usually about 10 minutes), then terminate with phosphoric acid and excite at 450 nm and read at 570 nm.

## 25 TNF $\alpha$ ELISA Assay

Coat Immulon<sup>®</sup> 2 plates with 0.1 mL/well of 1  $\mu$ g/mL Genzyme mAb in 0.1 M NaHCO<sub>3</sub> pH 8.0 buffer overnight (about 18-20 hours) at 4°C, wrapped tightly in Saran<sup>®</sup> wrap.

Flick out coating solution and block plates with 0.3 mL/well blocking buffer overnight at 4°C, wrapped in Saran® wrap.

Wash wells thoroughly 4X with wash buffer and completely remove all wash buffer. Add 0.1 mL/well of either samples or rhTNFα standards. Dilute samples if necessary in appropriate diluant (e.g. tissue culture medium). Dilute standard in same diluant. Standards and samples should be in triplicates.

Incubate at 37°C for 1 hour in humified container.

Wash plates as above. Add 0.1 mL/well of 1:200 dilution of Genzyme rabbit anti-hTNF .

Repeat incubation.

Repeat wash. Add 0.1 mL/well of 1 µg/mL Jackson goat anti-rabbit IgG (H+L)-peroxidase.

Incubate at 37°C for 30 minutes.

Repeat wash. Add 0.1 mL/well of peroxide-ABTS solution.

Incubate at room temperature for 5-20 minutes.

Read OD at 405 nm.

12 Reagents are:

Genzyme mouse anti-human TNF? monoclonal (Cat.# 80-3399-01)

Genzyme rabbit anti-human TNF? polyclonal (Cat.#IP-300)

Genzyme recombinant human TNF? (Cat.#TNF-H).

Jackson ImmunoResearch peroxide-conjugated goat anti-rabbit IgG (H+L) (Cat.#111-035-144).

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Kirkegaard/Perry peroxide ABTS solution  
(Cat#50-66-01).

Immulon 2 96-well microtiter plates.

Blocking solution is 1 mg/mL gelatin in PBS  
5 with 1X thimerasol.

Wash buffer is 0.5 mL Tween<sup>®</sup> 20 in 1 liter  
of PBS.

Results:

10

Example Number	MTS Toxicity TD <sub>50</sub> in micromolar	TNFR <sub>II</sub> Release IC <sub>50</sub> in micromolar	TNF $\alpha$ Release IC <sub>50</sub> in micromolar
DMSO	>100	>100	>100
4	>100	>100	>50
6	>100	>100	>50
9	>100	>100	>50
10	>100	>100	>50
13	>100	>100	>50
27	100	>100	>80
35	>100	>100	>80
69	100	>100	>80
95	>100	>100	>50
379	80	>100	80

Example 450: Pharmacokinetic (PK)-evaluation of MMP  
inhibitors in rats

15

Under metofane anesthesia, the femoral  
artery (all 8 rats) and femoral vein (only 4 of 8  
rats) are isolated and cannulated with PE50 tubing and  
secured with 3.0 silk suture. The following  
20 determinations require two catheters, with the venous  
line being used for infusion of compound (in the  
group of rats that receives compound via the  
intravenous (IV) route.), and the arterial line being  
used for collection of blood samples. The rats are

then placed in restraining cages that permit minimal movement and allowed to recover from anesthesia for approximately 30 minutes. At time 0 (prior to dosing), blood samples (400  $\mu$ L) are collected from  
5 arterial cannula.

One group of rats (4 rats per group) receives compound via the oral route at a dosing volume of 2 mL/kg (10mg/mL, dissolved in 0.5% methylcellulose, 0.1% Tween<sup>®</sup> 20), while the other  
10 group of rats receives compound via the intravenous cannula, at a dosing volume of 2 mL/kg (10 mg/mL, dissolved in 10% EtOH, 50% PEG 400, 40% saline). The blood samples are collected from the arterial cannula at 15, 30, 60, 120, 240, and 360 minutes from the  
15 oral group with an additional 3 minute sample being collected from IV group. After each sample, the cannulas are flushed with PBS containing 10 units/mL heparin. The animals are subjected to euthanasia with an excess of anesthesia or carbon monoxide  
20 asphyxiation when the study is terminated at 6 hours. Blood samples from each time point are assayed for MMP-13 enzyme inhibitory activity and the circulating concentration of compound plus active metabolites is estimated based on the standard curve.

25 Pharmacokinetic (PK) parameters are calculated by the VAX computer program CSTRIP. The parameters are defined in textbooks such as *Goodman and Gilman's The Pharmacological Basis of Therapeutics*, eighth ed., McGraw-Hill, Inc., New York (1993) and the references  
30 therein.

Example Number	Rat Intravenous			Rat Oral			
	20 mpk			20 mpk			
	$t_{1/2}$	AUC (0- $\infty$ )	Blood Level @ 3 min	C <sub>max</sub>	AUC (0-6 hr)	BA	Blood Level @ 6 hr
	Hour	hr* $\mu$ g/mL	$\mu$ g/mL	$\mu$ g/mL	hr* $\mu$ g/mL	%	$\mu$ g/mL
4	1.77	24.80	37.60	1.84	4.14	16.7	0.254
6	1.19	46.39	84.72	22.88	16.45	35.5	0.345
9	1.10	33.67	42.17	13.63	9.43	28.0	0.281
10	0.84	43.01	73.00	18.47	12.93	30.1	0.134
12	0.86	22.11	73.54	1.00	2.45	11.1	0.121
13	1.03	43.08	91.07	21.98	18.08	42.0	0.228
14	1.25	12.92	12.10	4.13	7.66	59.3	0.102
15	1.01	49.29	120.83	27.16	18.19	36.9	0.192
17	0.74	37.10	63.44	15.72	13.32	35.9	0.135
22	1.47	14.05	18.06	0.82	1.82	13.0	0.174
23	0.85	25.01	59.92	7.31	5.93	23.7	0.087
24	2.49	37.35	62.52	9.79	15.88	42.5	0.545
25	-	-	-	1.48	-	-	0.173
26	0.58	17.51	64.01	0.29	0.83	4.7	0.051
27	1.10	43.32	43.69	10.87	21.24	49.0	0.427
28	-	-	-	10.02	24.28	-	0.537
32	1.03	38.94	51.48	7.65	13.48	34.6	0.529
33	1.91	29.96	24.13	3.33	8.25	27.5	0.543
34	-	-	-	2.13	-	-	0.495
35	-	-	-	12.59	26.97	-	1.237
36	0.65	5.74	19.66	0.16	0.73	12.7	0.072
40	-	-	-	1.55	-	-	0.128
42	-	-	-	0.71	-	-	0.036
43	0.82	18.79	61.76	4.17	3.24	17.2	0.040
53	0.97	10.78	31.68	0.37	0.48	4.4	BLD
65	-	-	-	0.99	-	-	0.080
68	-	-	-	3.41	-	-	0.038
69	1.87	63.78	44.00	8.58	22.89	35.9	1.172
70	-	-	-	3.08	-	-	0.131
71	-	-	-	4.00	-	-	0.452
72	-	-	-	1.42	2.03	-	0.062
73	-	-	-	1.89	6.87	-	0.372
79	1.82	6.11	13.99	0.02	0.07	1.1	0.010
80	-	-	40.83	0.03	-	-	0.003
81	0.76	38.21	89.01	5.06	6.40	16.7	0.074
89	-	-	-	1.68	-	-	0.196
90	-	-	-	0.08	-	-	0.041
91	-	-	-	0.17	-	-	0.138
93	1.81	13.48	20.88	0.35	1.55	11.5	0.126
94	1.71	25.13	43.37	0.87	1.34	5.3	0.050
95	1.06	19.74	34.71	1.74	4.86	24.6	0.148
96	-	-	-	0.43	-	-	0.076
99	0.68	35.68	99.49	14.25	8.05	22.6	0.071
100	1.50	24.60	26.06	3.12	11.30	45.9	0.506
103	1.10	19.66	31.11	2.55	0.09	19.9	0.092
104	0.66	9.86	29.82	9.89	4.88	49.4	0.008
108	-	-	-	2.96	-	-	0.108
109	1.12	7.13	13.91	0.93	0.85	11.9	0.027
110	-	-	2.67	0.02	-	-	0.015

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111	0.65	8.49	33.56	0.45	1.11	13.1	0.054
115	1.36	7.81	12.95	1.17	2.00	25.6	0.058
117	0.78	8.69	40.50	0.18	0.28	3.3	0.016
118	1.85	10.97	17.18	0.75	3.32	30.3	0.268
121	-	-	-	0.31			0.055
123	-	-	-	1.43			0.017
125	0.73	15.73	25.36	1.11	2.50	15.9	0.119
233	0.85	23.12	31.90	3.33	6.22	26.9	0.584
379	1.74	51.41	37.54	4.30	16.80	32.7	1.154
382	1.71	73.68	48.81	7.27	36.12	49.0	3.113
387	-	-	-	0.65			0.558
388	0.94	26.10	34.62	0.15	0.68	2.6	0.073
390	1.50	127.63	120.60	23.21	44.20	34.6	1.780
391	1.45	120.92	82.87	24.02	73.24	60.6	2.680
400			104.34	8.55			0.160
408	3.30	25.18	57.40	9.46	4.17	16.6	0.015
410	1.78	29.83	40.08	0.63	2.08	6.7	0.223
414	0.73	26.15	61.89	5.31	6.22	23.8	0.021
416	2.94	230.70	111.17	29.63	156.71	67.9	20.52
418	2.42	209.92	78.55	20.65	77.52	36.9	7.347
421	-	-	-	13.08	19.21		0.206
427	2.85	36.72	50.74	4.16	8.44	23.0	0.440
437	-	-	-	4.21	4.43		0.128
438	2.14	9.05	7.46	0.39	1.86	20.6	0.316

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Example Number	Rat Intravenous			Rat Oral			
	20 mpk			20 mpk			
	t <sub>1/2</sub>	AUC (0-∞)	Blood Level @ 3 min	C <sub>max</sub>	AUC (0-6hr)	BA	Blood Level @ 6 hr
	Hour	hr*μg/mL	μg/mL	μg/mL	hr*μg/mL	%	μg/mL
4	1.77	24.80	37.60	1.84	4.14	16.7	0.254
6	1.19	46.39	84.72	22.88	16.45	35.5	0.345
9	1.10	33.67	42.17	13.63	9.43	28.0	0.281
10	0.84	43.01	73.00	18.47	12.93	30.1	0.134
12	0.86	22.11	73.54	1.00	2.45	11.1	0.121
13	1.03	43.08	91.07	21.98	18.08	42.0	0.228
14	1.25	12.92	12.10	4.13	7.66	59.3	0.102
15	1.01	49.29	120.83	27.16	18.19	36.9	0.192
17	0.74	37.10	63.44	15.72	13.32	35.9	0.135
22	1.47	14.05	18.06	0.82	1.82	13.0	0.174
23	0.85	25.01	59.92	7.31	5.93	23.7	0.087
24	2.49	37.35	62.52	9.79	15.88	42.5	0.545
25	-	-	-	1.48			0.173
26	0.58	17.51	64.01	0.29	0.83	4.7	0.051
27	1.10	43.32	43.69	10.87	21.24	49.0	0.427
28	-	-	-	10.02	24.28		0.537
32	1.03	38.94	51.48	7.65	13.48	34.6	0.529
33	1.91	29.96	24.13	3.33	8.25	27.5	0.543
34	-	-	-	2.13			0.495
35	-	-	-	12.59	26.97		1.237
36	0.65	5.74	19.66	0.16	0.73	12.7	0.072
40	-	-	-	1.55			0.128
42	-	-	-	0.71			0.036
43	0.82	18.79	61.76	4.17	3.24	17.2	0.040
53	0.97	10.78	31.68	0.37	0.48	4.4	BLD
65	-	-	-	0.99			0.080
68	-	-	-	3.41			0.038
69	1.87	63.78	44.00	8.58	22.89	35.9	1.172
70	-	-	-	3.08			0.131
71	-	-	-	4.00			0.452
72	-	-	-	1.42	2.03		0.062
73	-	-	-	1.89	6.87		0.372
79	1.82	6.11	13.99	0.02	0.07	1.1	0.010
80	-	-	40.83	0.03			0.003
81	0.76	38.21	89.01	5.06	6.40	16.7	0.074
89	-	-	-	1.68			0.196
90	-	-	-	0.08			0.041
91	-	-	-	0.17			0.138
93	1.81	13.48	20.88	0.35	1.55	11.5	0.126
94	1.71	25.13	43.37	0.87	1.34	5.3	0.050
95	1.06	19.74	34.71	1.74	4.86	24.6	0.148
96				0.43			0.076
99	0.68	35.68	99.49	14.25	8.05	22.6	0.071
100	1.50	24.60	26.06	3.12	11.30	45.9	0.506
103	1.10	19.66	31.11	2.55	0.09	19.9	0.092
104	0.66	9.86	29.82	9.89	4.88	49.4	0.008
108	-	-	-	2.96			0.108
109	1.12	7.13	13.91	0.93	0.85	11.9	0.027
110			2.67	0.02			0.015

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111	0.65	8.49	33.56	0.45	1.11	13.1	0.054
115	1.36	7.81	12.95	1.17	2.00	25.6	0.058
117	0.78	8.69	40.50	0.18	0.28	3.3	0.016
118	1.85	10.97	17.18	0.75	3.32	30.3	0.268
121	-	-	-	0.31			0.055
123	-	-	-	1.43			0.017
125	0.73	15.73	25.36	1.11	2.50	15.9	0.119
233	0.85	23.12	31.90	3.33	6.22	26.9	0.584
379	1.74	51.41	37.54	4.30	16.80	32.7	1.154
382	1.71	73.68	48.81	7.27	36.12	49.0	3.113
387	-	-	-	0.65			0.558
388	0.94	26.10	34.62	0.15	0.68	2.6	0.073
390	1.50	127.63	120.60	23.21	44.20	34.6	1.780
391	1.45	120.92	82.87	24.02	73.24	60.6	2.680
400			104.34	8.55			0.160
408	3.30	25.18	57.40	9.46	4.17	16.6	0.015
410	1.78	29.83	40.08	0.63	2.08	6.7	0.223
414	0.73	26.15	61.89	5.31	6.22	23.8	0.021
416	2.94	230.70	111.17	29.63	156.71	67.9	20.52
418	2.42	209.92	78.55	20.65	77.52	36.9	7.347
421	-	-	-	13.08	19.21		0.206
427	2.85	36.72	50.74	4.16	8.44	23.0	0.440
437	-	-	-	4.21	4.43		0.128
438	2.14	9.05	7.46	0.39	1.86	20.6	0.316

From the foregoing, it will be observed

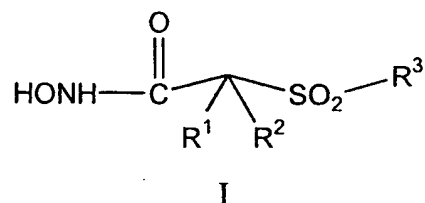
5 that numerous modifications and variations can be effectuated without departing from the true spirit and scope of the novel concepts of the present invention. It is to be understood that no limitation with respect to the specific example presented is

10 intended or should be inferred. The disclosure is intended to cover by the appended claims all such modifications as fall within the scope of the claims.



WHAT IS CLAIMED:

1. A process for treating a host mammal having a condition associated with pathological matrix metalloprotease (MMP) activity that comprises  
5 administering a metalloprotease inhibitor compound or a pharmaceutically acceptable salt thereof in an effective amount to a mammalian host having such a condition, said metalloprotease inhibitor inhibiting the activity of one or more of MMP-2, MMP-9 and MMP-  
10 13, while exhibiting substantially less inhibitory activity against MMP-1, said compound corresponding in structure to formula (I), below



15

wherein

$R^1$  and  $R^2$  are both hydrido or  $R^1$  and  $R^2$  together with the atoms to which they are bonded form a 5- to 8-membered ring containing one, two or three  
20 heteroatoms in the ring that are oxygen, sulfur or nitrogen;

$R^3$  is an optionally substituted aryl or optionally substituted heteroaryl radical, and when said aryl or heteroaryl radical is substituted, the  
25 substituent is (a) selected from the group consisting of an optionally substituted cycloalkyl, heterocycloalkyl, aryl, heteroaryl, aralkyl, heteroaralkyl, aralkoxy, heteroaralkoxy, aralkoxyalkyl, aryloxyalkyl, aralkanoylalkyl,

arylcarbonylalkyl, aralkylaryl, aryloxyalkylaryl,  
aralkoxyaryl, arylazoaryl, arylhydrazinoaryl,  
alkylthioaryl, arylthioalkyl, alkylthioaralkyl,  
aralkylthioalkyl, an aralkylthioaryl radical, the  
5 sulfoxide or sulfone of any of the thio substituents,  
and a fused ring structure comprising two or more 5-  
or 6-membered rings selected from the group  
consisting of aryl, heteroaryl, cycloalkyl and  
heterocycloalkyl, and (b) is itself optionally  
10 substituted with one or more substituents  
independently selected from the group consisting of a  
cyano, perfluoroalkyl, trifluoromethoxy,  
trifluoromethylthio, haloalkyl, trifluoromethylalkyl,  
aralkoxycarbonyl, aryloxycarbonyl, hydroxy, halo,  
15 alkyl, alkoxy, nitro, thiol, hydroxycarbonyl,  
aryloxy, arylthio, aralkyl, aryl, arylcarbonylamino,  
heteroaryloxy, heteroarylthio, heteroaralkyl,  
cycloalkyl, heterocyclooxy, heterocyclothio,  
heterocycloamino, cycloalkyloxy, cycloalkylthio,  
20 heteroaralkoxy, heteroaralkylthio, aralkoxy,  
aralkylthio, aralkylamino, heterocyclo, heteroaryl,  
arylazo, hydroxycarbonylalkoxy, alkoxycarbonylalkoxy,  
alkanoyl, arylcarbonyl, aralkanoyl, alkanoyloxy,  
aralkanoyloxy, hydroxyalkyl, hydroxyalkoxy,  
25 alkylthio, alkoxyalkylthio, alkoxycarbonyl,  
aryloxyalkoxyaryl, arylthioalkylthioaryl,  
aryloxyalkylthioaryl, arylthioalkoxyaryl,  
hydroxycarbonylalkoxy, hydroxycarbonylalkylthio,  
alkoxycarbonylalkoxy, alkoxycarbonylalkylthio, amino,  
30 wherein the amino nitrogen is (i) unsubstituted,  
or (ii) substituted with one or two substituents  
that are independently selected from the group  
consisting of an alkyl, aryl, heteroaryl,

aralkyl, cycloalkyl, aralkoxycarbonyl,  
alkoxycarbonyl, arylcarbonyl, aralkanoyl,  
heteroarylcarbonyl, heteroaralkanoyl and an  
alkanoyl group, or (iii) wherein the amino  
5 nitrogen and two substituents attached thereto  
form a 5- to 8-membered heterocyclo or  
heteroaryl ring containing zero to two  
additional heteroatoms that are nitrogen, oxygen  
or sulfur and which ring itself is (a)  
10 unsubstituted or (b) substituted with one or two  
groups independently selected from the group  
consisting of an aryl, alkyl, heteroaryl,  
aralkyl, heteroaralkyl, hydroxy, alkoxy,  
alkanoyl, cycloalkyl, heterocycloalkyl,  
15 alkoxycarbonyl, hydroxyalkyl, trifluoromethyl,  
benzofused heterocycloalkyl, hydroxyalkoxyalkyl,  
aralkoxycarbonyl, hydroxycarbonyl,  
aryloxycarbonyl, benzofused heterocycloalkoxy,  
benzofused cycloalkylcarbonyl, heterocyclo-  
20 alkylcarbonyl, and a cycloalkylcarbonyl group,  
carbonylamino  
wherein the carbonylamino nitrogen is (i)  
unsubstituted, or (ii) is the reacted amine of  
an amino acid, or (iii) substituted with one or  
25 two radicals selected from the group consisting  
of an alkyl, hydroxyalkyl, hydroxyheteroaralkyl,  
cycloalkyl, aralkyl, trifluoromethylalkyl,  
heterocycloalkyl, benzofused heterocycloalkyl,  
benzofused heterocycloalkyl, benzofused  
30 cycloalkyl, and an N,N-dialkylsubstituted  
alkylamino-alkyl group, or (iv) the carboxamido  
nitrogen and two substituents bonded thereto  
together form a 5- to 8-membered heterocyclo,

heteroaryl or benzofused heterocycloalkyl ring  
that is itself unsubstituted or substituted with  
one or two radicals independently selected from  
the group consisting of an alkyl,  
5 alkoxy carbonyl, nitro, heterocycloalkyl,  
hydroxy, hydroxycarbonyl, aryl, aralkyl,  
heteroaralkyl and an amino group,  
wherein the amino nitrogen is  
(i) unsubstituted, or (ii) substituted with  
10 one or two substituents that are  
independently selected from the group  
consisting of alkyl, aryl, and heteroaryl,  
or (iii) wherein the amino nitrogen and two  
substituents attached thereto form a 5- to  
15 8-membered heterocyclo or heteroaryl ring,  
and an aminoalkyl group  
wherein the aminoalkyl nitrogen is (i)  
unsubstituted, or (ii) substituted with one or two  
substituents independently selected from the group  
20 consisting of an alkyl, aryl, aralkyl, cycloalkyl,  
aralkoxycarbonyl, alkoxy carbonyl, and an alkanoyl  
group, or (iii) wherein the aminoalkyl nitrogen and  
two substituents attached thereto form a 5- to 8-  
membered heterocyclo or heteroaryl ring.

25

2. The process according to claim 1  
wherein  $R^1$  and  $R^2$  together with the atoms to which  
they are bonded form a 5- to 8-membered ring  
containing one, two or three heteroatoms in the ring  
30 that are oxygen, sulfur or nitrogen;

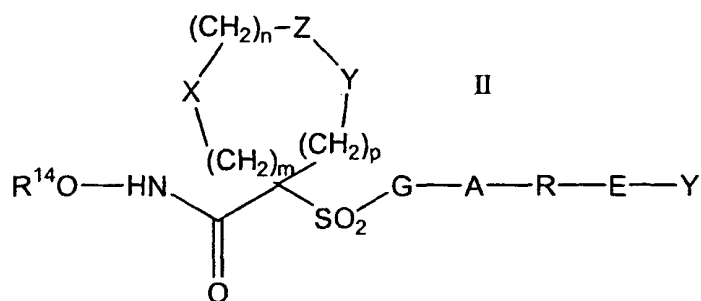
3. The process according to claim 2  
wherein  $R^3$  is a single-ringed aryl or heteroaryl  
group that is 5- or 6-membered, and is itself  
substituted at its own 4-position when a 6-membered  
5 ring or at its own 3- or 4-position when a 5-membered  
ring with a substituent selected from the group  
consisting of one other single-ringed aryl or  
heteroaryl group, a  $C_3$ - $C_{14}$  alkyl group, a N-piperidyl  
group, a N-piperazinyl group, a phenoxy group, a  
10 thiophenoxy group, a 4-thiopyridyl group, a phenylazo  
group and a benzamido group.

4. The process according to claim 3  
wherein  $R^3$  contains two or more 5- or 6-membered  
15 rings.

5. The process according to claim 3  
wherein  $R^3$ , when rotated about an axis drawn through  
the  $SO_2$ -bonded 1-position and the substituent-bonded  
20 4-position of a 6-membered ring or the  $SO_2$ -bonded 1-  
position and substituent-bonded 3- or 4-position of a  
5-membered ring, defines a three-dimensional volume  
whose widest dimension has the width in a direction  
transverse to that axis to rotation of about one  
25 furanyl ring to about two phenyl rings.

6. The process according to claim 3  
wherein  $R^3$  has a length that is greater than that of  
a pentyl group and a length that is less than that of  
30 an icosyl group.

7. A process for treating a host mammal having a condition associated with pathological matrix metalloprotease (MMP) activity that comprises administering a metalloprotease inhibitor compound or  
 5 a pharmaceutically acceptable salt thereof in an effective amount to a mammalian host having such a condition, said metalloprotease inhibitor inhibiting the activity of one or more of MMP-2, MMP-9 and MMP-13, while exhibiting substantially less inhibitory  
 10 activity against MMP-1, said compound corresponding in structure to formula II, below



15 wherein

$R^{14}$  is hydrido, a pharmaceutically acceptable cation or  $C(W)R^{15}$  where W is O or S and  $R^{15}$  is selected from the group consisting of a  $C_1$ - $C_6$ -alkyl, aryl,  $C_1$ - $C_6$ -alkoxy, heteroaryl- $C_1$ - $C_6$ -alkyl,  
 20  $C_3$ - $C_8$ -cycloalkyl- $C_1$ - $C_6$ -alkyl, aryloxy, ar- $C_1$ - $C_6$ -alkoxy, ar- $C_1$ - $C_6$ -alkyl, heteroaryl and amino  $C_1$ - $C_6$ -alkyl group wherein the aminoalkyl nitrogen is (i) unsubstituted or (ii) substituted with one or two substituents independently selected from the group  
 25 consisting of an  $C_1$ - $C_6$ -alkyl, aryl, ar- $C_1$ - $C_6$ -alkyl,

C<sub>3</sub>-C<sub>8</sub>-cycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkoxycarbonyl, C<sub>1</sub>-C<sub>6</sub>-alkoxycarbonyl, and C<sub>1</sub>-C<sub>6</sub>-alkanoyl radical, or (iii) wherein the amino C<sub>1</sub>-C<sub>6</sub>-alkyl nitrogen and two substituents attached thereto  
5 form a 5- to 8-membered heterocyclo or heteroaryl ring;

m is zero, 1 or 2;

n is zero, 1 or 2;

p is zero, 1 or 2;

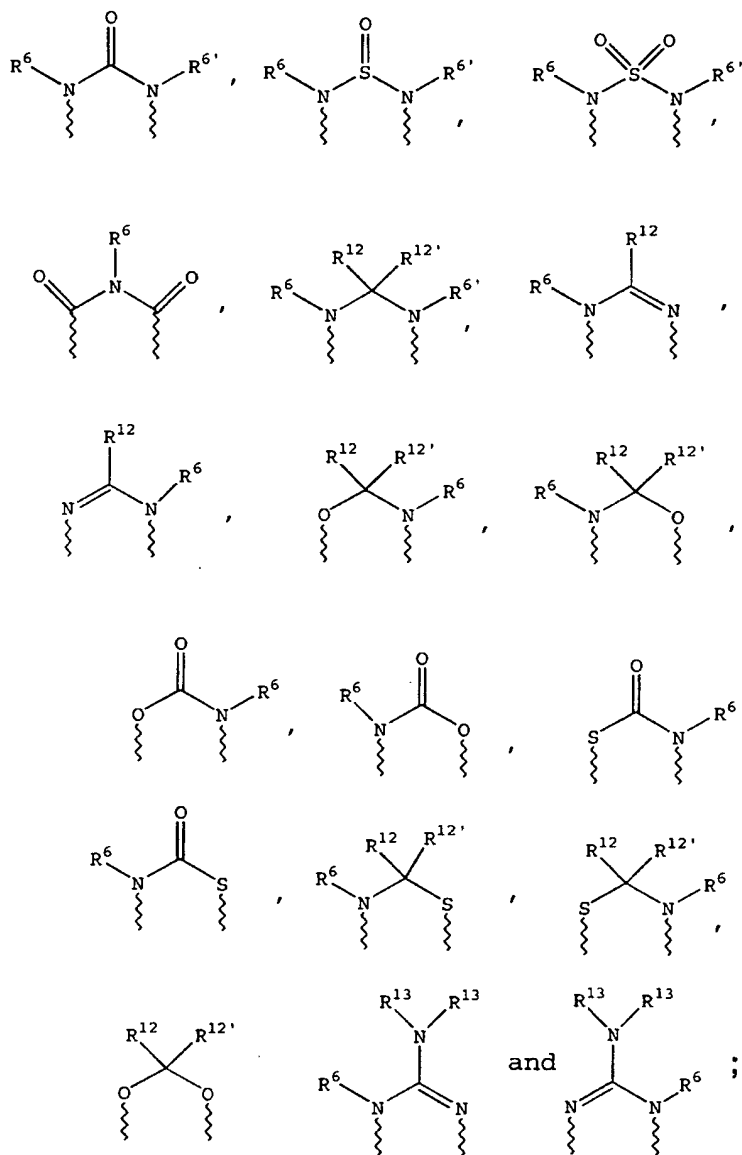
10 the sum of m + n + p = 1, 2, 3 or 4;

(a) one of X, Y and Z is selected from the group consisting of C(O), NR<sup>6</sup>, O, S, S(O), S(O)<sub>2</sub> and NS(O)<sub>2</sub>R<sup>7</sup>, and the remaining two of X, Y and Z are CR<sup>8</sup>R<sup>9</sup>, and CR<sup>10</sup>R<sup>11</sup>, or

15 (b) X and Z or Z and Y together constitute a moiety that is selected from the group consisting of NR<sup>6</sup>C(O), NR<sup>6</sup>S(O), NR<sup>6</sup>S(O)<sub>2</sub>, NR<sup>6</sup>S, NR<sup>6</sup>O, SS, NR<sup>6</sup>NR<sup>6</sup> and OC(O), with the remaining one of X, Y and Z being CR<sup>8</sup>R<sup>9</sup>, or

20 (c) n is zero and X, Y and Z together constitute a moiety selected from the group consisting of

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5                    wherein wavy lines are bonds to the atoms  
of the depicted ring;

$R^6$  and  $R^{6'}$  are independently selected from  
the group consisting of hydrido,  $C_1$ - $C_6$ -alkanoyl,  $C_6$ -  
aryl- $C_1$ - $C_6$ -alkyl, aroyl, bis( $C_1$ - $C_6$ -alkoxy- $C_1$ - $C_6$ -  
10 alkyl)- $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_6$ -haloalkyl,  $C_1$ -  
 $C_6$ -perfluoroalkyl,  $C_1$ - $C_6$ -trifluoromethylalkyl,  $C_1$ - $C_6$ -



perfluoroalkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>6</sub>-cycloalkyl, C<sub>3</sub>-C<sub>8</sub>-heterocycloalkyl, C<sub>3</sub>-C<sub>8</sub>-heterocycloalkylcarbonyl, C<sub>6</sub>-aryl, C<sub>5</sub>-C<sub>6</sub>-heterocyclo, C<sub>5</sub>-C<sub>6</sub>-heteroaryl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>6</sub>-aryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryl-C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroarylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>6</sub>-arylsulfonyl, C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl, C<sub>5</sub>-C<sub>6</sub>-heteroarylsulfonyl, carboxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>4</sub>-alkoxycarbonyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, aminocarbonyl, C<sub>1</sub>-C<sub>6</sub>-alkyliminocarbonyl, C<sub>6</sub>-aryliminocarbonyl, C<sub>5</sub>-C<sub>6</sub>-heterocycloiminocarbonyl, C<sub>6</sub>-arylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>6</sub>-arylthio-C<sub>3</sub>-C<sub>6</sub>-alkenyl, C<sub>1</sub>-C<sub>4</sub>-alkylthio-C<sub>3</sub>-C<sub>6</sub>-alkenyl, C<sub>5</sub>-C<sub>6</sub>-heteroaryl-C<sub>1</sub>-C<sub>6</sub>-alkyl, halo-C<sub>1</sub>-C<sub>6</sub>-alkanoyl, hydroxy-C<sub>1</sub>-C<sub>6</sub>-alkanoyl, thiol-C<sub>1</sub>-C<sub>6</sub>-alkanoyl, C<sub>3</sub>-C<sub>6</sub>-alkenyl, C<sub>3</sub>-C<sub>6</sub>-alkynyl, C<sub>1</sub>-C<sub>4</sub>-alkoxy-C<sub>1</sub>-C<sub>4</sub>-alkyl, C<sub>1</sub>-C<sub>5</sub>-alkoxycarbonyl, aryloxycarbonyl, NR<sup>8</sup>R<sup>9</sup>-C<sub>1</sub>-C<sub>5</sub>-alkylcarbonyl, hydroxy-C<sub>1</sub>-C<sub>5</sub>-alkyl, an aminocarbonyl wherein the aminocarbonyl nitrogen is (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl and a C<sub>1</sub>-C<sub>6</sub>-alkanoyl group, hydroxyaminocarbonyl, an aminosulfonyl group wherein the aminosulfonyl nitrogen is (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl and a

C<sub>1</sub>-C<sub>6</sub>-alkanoyl group, an amino-C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl group wherein the amino-C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl nitrogen is (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl and a C<sub>1</sub>-C<sub>6</sub>-alkanoyl group and an amino-C<sub>1</sub>-C<sub>6</sub>-alkyl group wherein the aminoalkyl nitrogen is (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl and a C<sub>1</sub>-C<sub>6</sub>-alkanoyl group;

R<sup>7</sup> is selected from the group consisting of a arylalkyl, aryl, heteroaryl, heterocyclo, C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>6</sub>-alkynyl, C<sub>3</sub>-C<sub>6</sub>-alkenyl, C<sub>1</sub>-C<sub>6</sub>-carboxyalkyl and a C<sub>1</sub>-C<sub>6</sub>-hydroxyalkyl group;

R<sup>8</sup> and R<sup>9</sup> and R<sup>10</sup> and R<sup>11</sup> are independently selected from the group consisting of a hydrido, hydroxy, C<sub>1</sub>-C<sub>6</sub>-alkyl, aryl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryl, heteroar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>2</sub>-C<sub>6</sub>-alkynyl, C<sub>2</sub>-C<sub>6</sub>-alkenyl, thiol-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl cycloalkyl, cycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, heterocycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, aralkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxycarbonyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxycarbonylar-C<sub>1</sub>-C<sub>6</sub>-alkyl, aminocarbonyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, aryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, arylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroarylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, the sulfoxide or

sulfone of any said thio substituents, perfluoro-C<sub>1</sub>-C<sub>6</sub>-alkyl, trifluoromethyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, halo-C<sub>1</sub>-C<sub>6</sub>-alkyl, alkoxycarbonylamino-C<sub>1</sub>-C<sub>6</sub>-alkyl and an amino-C<sub>1</sub>-C<sub>6</sub>-alkyl group wherein the aminoalkyl nitrogen is

5 (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, cycloalkyl and C<sub>1</sub>-C<sub>6</sub>-alkanoyl, or wherein R<sup>8</sup> and R<sup>9</sup> or R<sup>10</sup> and R<sup>11</sup> and the carbon to which they are bonded form a

10 carbonyl group, or wherein R<sup>8</sup> and R<sup>9</sup> or R<sup>10</sup> and R<sup>11</sup>, or R<sup>8</sup> and R<sup>10</sup> together with the atoms to which they are bonded form a 5- to 8-membered carbocyclic ring, or a 5- to 8-membered heterocyclic ring containing one or two heteroatoms that are nitrogen, oxygen, or

15 sulfur, with the proviso that only one of R<sup>8</sup> and R<sup>9</sup> or R<sup>10</sup> and R<sup>11</sup> is hydroxy;

R<sup>12</sup> and R<sup>12'</sup> are independently selected from the group consisting of a hydrido, C<sub>1</sub>-C<sub>6</sub>-alkyl, aryl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryl, heteroaralkyl, C<sub>2</sub>-C<sub>6</sub>-alkynyl, C<sub>2</sub>-C<sub>6</sub>-alkenyl, thiol-C<sub>1</sub>-C<sub>6</sub>-alkyl,

20 cycloalkyl, cycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, heterocycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, aryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, amino-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxycarbonyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxycarbonylar-C<sub>1</sub>-C<sub>6</sub>-alkyl,

25 aminocarbonyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, aryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, arylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroarylthio-C<sub>1</sub>-C<sub>6</sub>-

alkyl, the sulfoxide or sulfone of any said thio substituents, perfluoro-C<sub>1</sub>-C<sub>6</sub>-alkyl, trifluoromethyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, halo-C<sub>1</sub>-C<sub>6</sub>-alkyl, alkoxycarbonylamino-C<sub>1</sub>-C<sub>6</sub>-alkyl and an amino-C<sub>1</sub>-C<sub>6</sub>-alkyl group wherein  
5 the aminoalkyl nitrogen is (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, cycloalkyl and C<sub>1</sub>-C<sub>6</sub>-alkanoyl;

R<sup>13</sup> is selected from the group consisting  
10 of a hydrido, benzyl, phenyl, C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>2</sub>-C<sub>6</sub>-alkynyl, C<sub>2</sub>-C<sub>6</sub>-alkenyl and a C<sub>1</sub>-C<sub>6</sub>-hydroxyalkyl group; and

G-A-R-E-Y is a substituent that has a length greater than that of a pentyl group has a  
15 length that is less than that of an icosyl group wherein

G is an aryl or heteroaryl group;

A is selected from the group consisting of

- 20 (1) -O-;  
(2) -S-;  
(3) -NR<sup>17</sup>-;  
(4) -CO-N(R<sup>17</sup>) or -N(R<sup>17</sup>)-CO-, wherein R<sup>17</sup> is hydrogen, C<sub>1</sub>-C<sub>4</sub>-alkyl, or phenyl;  
(5) -CO-O- or -O-CO-;  
25 (6) -O-CO-O-;  
(7) -HC=CH-;  
(8) -NH-CO-NH-;  
(9) -C≡C-;  
(10) -NH-CO-O- or -O-CO-NH-;

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(11) -N=N-;

(12) -NH-NH-; and

(13) -CS-N(R<sup>18</sup>)- or -N(R<sup>18</sup>)-CS-, whereinR<sup>18</sup> is hydrogen C<sub>1</sub>-C<sub>4</sub>-alkyl, or

5 phenyl; or

(14) A is absent and G is bonded directly to R;

R is a moiety selected from the group consisting of alkyl, alkoxyalkyl, aryl, heteroaryl, cycloalkyl, heterocycloalkyl, aralkyl, heteroaralkyl, heterocycloalkylalkyl, cycloalkylalkyl, cycloalkoxyalkyl, heterocycloalkoxyalkyl, aryloxyalkyl, heteroaryloxyalkyl, arylthioalkyl, heteroarylthioalkyl, cycloalkylthioalkyl, and a

10 heterocycloalkylthioalkyl group wherein the aryl or heteroaryl or cycloalkyl or heterocycloalkyl substituent is (i) unsubstituted or (ii) substituted with one or two radicals selected from the group consisting of a halo, alkyl, perfluoroalkyl,

20 perfluoroalkoxy, perfluoroalkylthio, trifluoromethylalkyl, amino, alkoxycarbonylalkyl, alkoxy, C<sub>1</sub>-C<sub>2</sub>-alkylene-dioxy, hydroxycarbonylalkyl, hydroxycarbonylalkylamino, nitro, hydroxy, hydroxyalkyl, alkanoylamino, and a alkoxycarbonyl

25 group, and R is other than alkyl or alkoxyalkyl when A is -O- or -S-;

E is selected from the group consisting of

(1) -CO(R<sup>19</sup>)- or -(R<sup>19</sup>)CO-, wherein R<sup>19</sup> is a heterocycloalkyl, or a cycloalkyl

30 group;

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(2) -CONH- or -HNCO-; and

(3) -CO-;

(4) -SO<sub>2</sub>-R<sup>19</sup>- or -R<sup>19</sup>-SO<sub>2</sub>-;

(5) -SO<sub>2</sub>-;

5 (6) -NH-SO<sub>2</sub>- or -SO<sub>2</sub>-NH-; or

(7) E is absent and R is bonded directly  
to Y; and

Y is absent or is selected from the group  
consisting of a hydrido, alkyl, alkoxy, haloalkyl,  
10 aryl, aralkyl, cycloalkyl, heteroaryl, hydroxy,  
aryloxy, aralkoxy, heteroaryloxy, heteroaralkyl,  
perfluoroalkoxy, perfluoroalkylthio,  
trifluoromethylalkyl, alkenyl, heterocycloalkyl,  
cycloalkyl, trifluoromethyl, alkoxycarbonyl, and a  
15 aminoalkyl group, wherein the aryl or heteroaryl or  
heterocycloalkyl group is (i) unsubstituted or (ii)  
substituted with one or two radicals independently  
selected from the group consisting of an alkanoyl,  
halo, nitro, aralkyl, aryl, alkoxy, and an amino  
20 group wherein the amino nitrogen is (i) unsubstituted  
or (ii) substituted with one or two groups  
independently selected from hydrido, alkyl, and an  
aralkyl group.

25 8. The process according to claim 7  
wherein said -G-A-R-E-Y substituent contains two to  
four carbocyclic or heterocyclic rings.

9. The process according to claim 8  
30 wherein each of the two to four rings is 6-membered.

10. The process according to claim 7 wherein said -G-A-R-E-Y substituent has a length that is greater than a hexyl group and a length that is less than that of a stearyl group.

5

11. The process according to claim 7 wherein A is -O- or -S-.

12. The process according to claim 7 wherein R is an aryl, heteroaryl, cycloalkyl or heterocycloalkyl group.

13. The process according to claim 7 wherein E is absent.

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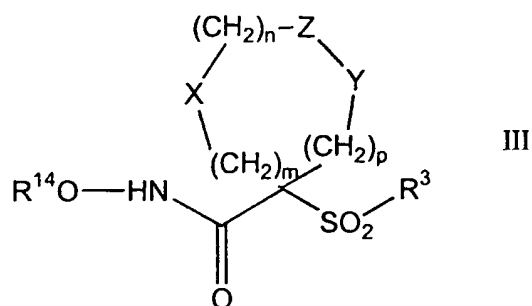
14. The process according to claim 7 wherein Y is selected from the group consisting of hydrido, an alkyl, alkoxy, perfluoroalkoxy and a perfluoroalkylthio group.

20

15. A process for treating a host mammal having a condition associated with pathological matrix metalloprotease (MMP) activity that comprises administering a metalloprotease inhibitor compound or a pharmaceutically acceptable salt thereof in an effective amount to a mammalian host having such a condition, said metalloprotease inhibitor inhibiting the activity of one or more of MMP-2, MMP-9 and MMP-13, while exhibiting substantially less inhibitory activity against MMP-1, said compound corresponding in structure to formula III, below

25  
30

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wherein

$R^3$  is a single-ringed aryl or heteroaryl group that is 5- or 6-membered, and is itself substituted at its own 4-position when a 6-membered ring and at its own 3- or 4-position when a 5-membered ring with a substituent selected from the group consisting of a thiophenoxy, 4-chloro-phenoxy, 3-chlorophenoxy, 4-methoxyphenoxy, 3-benzodioxol-5-yloxy, 3,4-dimethylphenoxy, 4-fluorophenoxy, 4-fluorothiophenoxy, phenoxy, 4-trifluoromethoxyphenoxy, 4-trifluoromethylphenoxy, 4-(trifluoromethylthio)phenoxy, 4-(trifluoromethylthio)thiophenoxy, 4-chloro-3-fluorophenoxy, 4-isopropoxyphenoxy, 4-isopropylphenoxy, (2-methyl-1,3-benzothiazol-5-yl)oxy, 4-(1H-imidazol-1-yl)phenoxy, 4-chloro-3-methylphenoxy, 3-methyl-phenoxy, 4-ethoxyphenoxy, 3,4-difluorophenoxy, 4-chloro-3-methylphenoxy, 4-fluoro-3-chlorophenoxy, 4-(1H-1,2,4-triazol-1-yl)phenoxy, 3,5-difluorophenoxy, 3,4-dichlorophenoxy, 4-cyclopentylphenoxy, 4-bromo-3-methylphenoxy, 4-bromophenoxy, 4-methylthiophenoxy, 4-phenylphenoxy, 4-benzylphenoxy, 6-quinolinylloxy, 4-amino-3-methylphenoxy, 3-methoxyphenoxy, 5,6,7,8-tetrahydro-2-naphthalenyloxy, 3-hydroxymethylphenoxy, and a 4-benzyloxyphenoxy group;



$R^{14}$  is hydrido, a pharmaceutically acceptable cation or  $C(W)R^{15}$  where W is O or S and  $R^{15}$  is selected from the group consisting of a  $C_1-C_6$ -alkyl, aryl,  $C_1-C_6$ -alkoxy, heteroaryl- $C_1-C_6$ -alkyl,  $C_3-C_8$ -cycloalkyl- $C_1-C_6$ -alkyl, aryloxy, ar- $C_1-C_6$ -alkoxy, ar- $C_1-C_6$ -alkyl, heteroaryl and amino  $C_1-C_6$ -alkyl group wherein the aminoalkyl nitrogen is (i) unsubstituted or (ii) substituted with one or two substituents independently selected from the group consisting of an  $C_1-C_6$ -alkyl, aryl, ar- $C_1-C_6$ -alkyl,  $C_3-C_8$ -cycloalkyl- $C_1-C_6$ -alkyl, ar- $C_1-C_6$ -alkoxycarbonyl,  $C_1-C_6$ -alkoxycarbonyl, and  $C_1-C_6$ -alkanoyl radical, or (iii) wherein the amino  $C_1-C_6$ -alkyl nitrogen and two substituents attached thereto form a 5- to 8-membered heterocyclo or heteroaryl ring;

m is zero, 1 or 2;

n is zero, 1 or 2;

p is zero, 1 or 2;

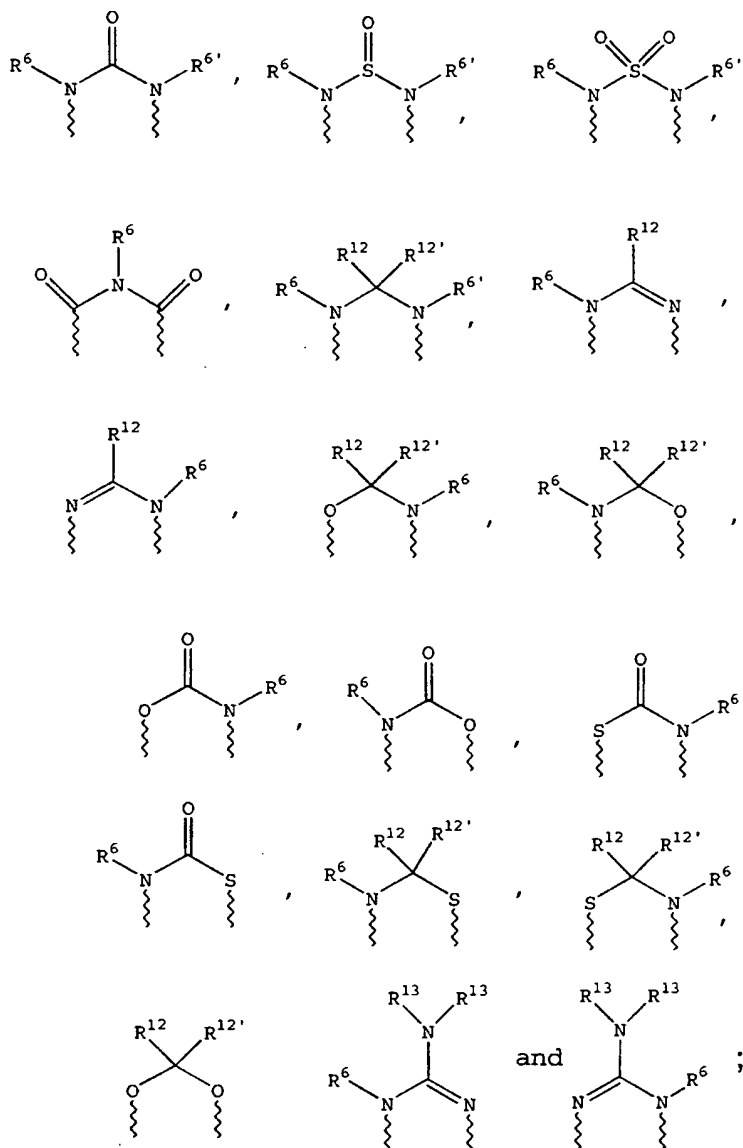
the sum of  $m + n + p = 1, 2, 3$  or 4;

(a) one of X, Y and Z is selected from the group consisting of  $C(O)$ ,  $NR^6$ , O, S,  $S(O)$ ,  $S(O)_2$  and  $NS(O)_2R^7$ , and the remaining two of X, Y and Z are  $CR^8R^9$ , and  $CR^{10}R^{11}$ , or

(b) X and Z or Z and Y together constitute a moiety that is selected from the group consisting of  $NR^6C(O)$ ,  $NR^6S(O)$ ,  $NR^6S(O)_2$ ,  $NR^6S$ ,  $NR^6O$ ,  $SS$ ,  $NR^6NR^6$  and  $OC(O)$ , with the remaining one of X, Y and Z being  $CR^8R^9$ , or

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(c) n is zero and X, Y and Z together constitute a moiety selected from the group consisting of



$R^6$  and  $R^{6'}$  are independently selected from the group consisting of hydrido,  $C_1$ - $C_6$ -alkanoyl,  $C_6$ -aryl- $C_1$ - $C_6$ -alkyl, aroyl, bis( $C_1$ - $C_6$ -alkoxy- $C_1$ - $C_6$ -alkyl)- $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_6$ -haloalkyl,  $C_1$ -  
5  $C_6$ -perfluoroalkyl,  $C_1$ - $C_6$ -trifluoromethylalkyl,  $C_1$ - $C_6$ -perfluoroalkoxy- $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_6$ -alkoxy- $C_1$ - $C_6$ -alkyl,  $C_3$ - $C_6$ -cycloalkyl,  $C_3$ - $C_8$ -heterocycloalkyl,  $C_3$ - $C_8$ -heterocycloalkylcarbonyl,  $C_6$ -aryl,  $C_5$ - $C_6$ -heterocyclo,  $C_5$ - $C_6$ -heteroaryl,  $C_3$ - $C_8$ -cycloalkyl- $C_1$ -  
10  $C_6$ -alkyl,  $C_6$ -aryloxy- $C_1$ - $C_6$ -alkyl, heteroaryloxy- $C_1$ - $C_6$ -alkyl, heteroaryl- $C_1$ - $C_6$ -alkoxy- $C_1$ - $C_6$ -alkyl, heteroarylthio- $C_1$ - $C_6$ -alkyl,  $C_6$ -arylsulfonyl,  $C_1$ - $C_6$ -alkylsulfonyl,  $C_5$ - $C_6$ -heteroarylsulfonyl, carboxy- $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_4$ -alkoxycarbonyl- $C_1$ - $C_6$ -alkyl,  
15 aminocarbonyl,  $C_1$ - $C_6$ -alkyliminocarbonyl,  $C_6$ -aryliminocarbonyl,  $C_5$ - $C_6$ -heterocycloiminocarbonyl,  $C_6$ -arylthio- $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_6$ -alkylthio- $C_1$ - $C_6$ -alkyl,  $C_6$ -arylthio- $C_3$ - $C_6$ -alkenyl,  $C_1$ - $C_4$ -alkylthio- $C_3$ - $C_6$ -alkenyl,  $C_5$ - $C_6$ -heteroaryl- $C_1$ - $C_6$ -alkyl, halo- $C_1$ - $C_6$ -  
20 alkanoyl, hydroxy- $C_1$ - $C_6$ -alkanoyl, thiol- $C_1$ - $C_6$ -alkanoyl,  $C_3$ - $C_6$ -alkenyl,  $C_3$ - $C_6$ -alkynyl,  $C_1$ - $C_4$ -alkoxy- $C_1$ - $C_4$ -alkyl,  $C_1$ - $C_5$ -alkoxycarbonyl, aryloxycarbonyl,  $NR^8R^9$ - $C_1$ - $C_5$ -alkylcarbonyl, hydroxy- $C_1$ - $C_5$ -alkyl, an  
aminocarbonyl wherein the aminocarbonyl nitrogen is  
25 (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of  $C_1$ - $C_6$ -alkyl, ar- $C_1$ - $C_6$ -alkyl,  $C_3$ - $C_8$ -cycloalkyl and a  $C_1$ - $C_6$ -alkanoyl group,

hydroxyaminocarbonyl, an aminosulfonyl group wherein the aminosulfonyl nitrogen is (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl and a C<sub>1</sub>-C<sub>6</sub>-alkanoyl group, an amino-C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl group wherein the amino-C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl nitrogen is (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl and a C<sub>1</sub>-C<sub>6</sub>-alkanoyl group and an amino-C<sub>1</sub>-C<sub>6</sub>-alkyl group wherein the aminoalkyl nitrogen is (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl and a C<sub>1</sub>-C<sub>6</sub>-alkanoyl group;

R<sup>7</sup> is selected from the group consisting of a arylalkyl, aryl, heteroaryl, heterocyclo, C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>6</sub>-alkynyl, C<sub>3</sub>-C<sub>6</sub>-alkenyl, C<sub>1</sub>-C<sub>6</sub>-carboxyalkyl and a C<sub>1</sub>-C<sub>6</sub>-hydroxyalkyl group;

R<sup>8</sup> and R<sup>9</sup> and R<sup>10</sup> and R<sup>11</sup> are independently selected from the group consisting of a hydrido, hydroxy, C<sub>1</sub>-C<sub>6</sub>-alkyl, aryl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryl, heteroar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>2</sub>-C<sub>6</sub>-alkynyl, C<sub>2</sub>-C<sub>6</sub>-alkenyl, thiol-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl cycloalkyl, cycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, heterocycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, aralkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxy-C<sub>1</sub>-C<sub>6</sub>-alkyl,

hydroxycarbonyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxycarbonylar-C<sub>1</sub>-C<sub>6</sub>-alkyl, aminocarbonyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, aryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, arylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroarylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, the sulfoxide or sulfone of any said thio substituents, perfluoro-C<sub>1</sub>-C<sub>6</sub>-alkyl, trifluoromethyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, halo-C<sub>1</sub>-C<sub>6</sub>-alkyl, alkoxycarbonylamino-C<sub>1</sub>-C<sub>6</sub>-alkyl and an amino-C<sub>1</sub>-C<sub>6</sub>-alkyl group wherein the aminoalkyl nitrogen is (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, cycloalkyl and C<sub>1</sub>-C<sub>6</sub>-alkanoyl, or wherein R<sup>8</sup> and R<sup>9</sup> or R<sup>10</sup> and R<sup>11</sup> and the carbon to which they are bonded form a carbonyl group, or wherein R<sup>8</sup> and R<sup>9</sup> or R<sup>10</sup> and R<sup>11</sup>, or R<sup>8</sup> and R<sup>10</sup> together with the atoms to which they are bonded form a 5- to 8-membered carbocyclic ring, or a 5- to 8-membered heterocyclic ring containing one or two heteroatoms that are nitrogen, oxygen, or sulfur, with the proviso that only one of R<sup>8</sup> and R<sup>9</sup> or R<sup>10</sup> and R<sup>11</sup> is hydroxy;

R<sup>12</sup> and R<sup>12'</sup> are independently selected from the group consisting of a hydrido, C<sub>1</sub>-C<sub>6</sub>-alkyl, aryl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryl, heteroaralkyl, C<sub>2</sub>-C<sub>6</sub>-alkynyl, C<sub>2</sub>-C<sub>6</sub>-alkenyl, thiol-C<sub>1</sub>-C<sub>6</sub>-alkyl, cycloalkyl, cycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, heterocycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, aryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, amino-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxycarbonyl-C<sub>1</sub>-

C<sub>6</sub>-alkyl, hydroxycarbonylar-C<sub>1</sub>-C<sub>6</sub>-alkyl,  
aminocarbonyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, aryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl,  
heteroaryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkylthio-C<sub>1</sub>-C<sub>6</sub>-  
alkyl, arylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroarylthio-C<sub>1</sub>-C<sub>6</sub>-  
5 alkyl, the sulfoxide or sulfone of any said thio  
substituents, perfluoro-C<sub>1</sub>-C<sub>6</sub>-alkyl, trifluoromethyl-  
C<sub>1</sub>-C<sub>6</sub>-alkyl, halo-C<sub>1</sub>-C<sub>6</sub>-alkyl, alkoxycarbonylamino-  
C<sub>1</sub>-C<sub>6</sub>-alkyl and an amino-C<sub>1</sub>-C<sub>6</sub>-alkyl group wherein  
the aminoalkyl nitrogen is (i) unsubstituted or (ii)  
10 substituted with one or two radicals independently  
selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl,  
ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, cycloalkyl and C<sub>1</sub>-C<sub>6</sub>-alkanoyl; and  
R<sup>13</sup> is selected from the group consisting  
of a hydrido, benzyl, phenyl, C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>2</sub>-C<sub>6</sub>-  
15 alkynyl, C<sub>2</sub>-C<sub>6</sub>-alkenyl and a C<sub>1</sub>-C<sub>6</sub>-hydroxyalkyl  
group.

16. The process according to claim 15  
wherein the sum of m + n + p = 1 or 2.

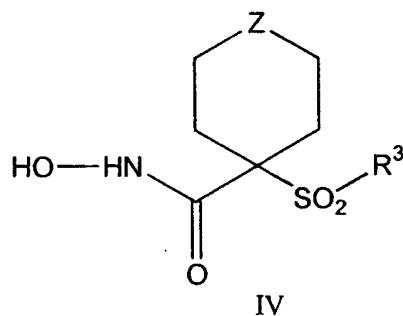
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17. The process according to claim 15  
wherein Z is O, S or NR<sup>6</sup>.

18. The process according to claim 15  
25 wherein R<sup>6</sup> is selected from the group consisting of  
C<sub>3</sub>-C<sub>6</sub>-cycloalkyl, C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>6</sub>-alkenyl, C<sub>3</sub>-C<sub>6</sub>-  
alkynyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, amino-C<sub>1</sub>-C<sub>6</sub>-alkyl,  
aminosulfonyl, heteroaryl-C<sub>1</sub>-C<sub>6</sub>-alkyl,  
aryloxycarbonyl, and C<sub>1</sub>-C<sub>6</sub>-alkoxycarbonyl.

19. The process according to claim 15 wherein  $m = n = \text{zero}$ ,  $p = 1$ , and  $Y$  is  $\text{NR}^6$ .

5           20. A process for treating a host mammal having a condition associated with pathological matrix metalloprotease (MMP) activity that comprises administering a metalloprotease inhibitor compound or a pharmaceutically acceptable salt thereof in an effective amount to a mammalian host having such a condition, said metalloprotease inhibitor inhibiting the activity of one or more of MMP-2, MMP-9 and MMP-13, while exhibiting substantially less inhibitory activity against MMP-1, said compound corresponding  
10           in structure to formula IV, below  
15



          wherein  $\text{R}^3$  is an optionally substituted aryl or optionally substituted heteroaryl radical, and when said aryl or heteroaryl radical is substituted, the substituent is (a) selected from the group consisting of an optionally substituted cycloalkyl, heterocycloalkyl, aryl, heteroaryl, aralkyl, heteroaralkyl, aralkoxy, heteroaralkoxy,  
20           aralkoxyalkyl, aryloxyalkyl, aralkanoylalkyl, arylcarbonylalkyl, aralkylaryl, aryloxyalkylaryl,  
25

aralkoxyaryl, arylazoaryl, arylhydrazinoaryl,  
alkylthioaryl, arylthioalkyl, alkylthioaralkyl,  
aralkylthioalkyl, an aralkylthioaryl radical, the  
sulfoxide or sulfone of any of the thio substituents,  
5 and a fused ring structure comprising two or more 5-  
or 6-membered rings selected from the group  
consisting of aryl, heteroaryl, cycloalkyl and  
heterocycloalkyl, and (b) is itself optionally  
substituted with one or more substituents  
10 independently selected from the group consisting of a  
cyano, perfluoroalkyl, trifluoromethoxy,  
trifluoromethylthio, haloalkyl, trifluoromethylalkyl,  
aralkoxycarbonyl, aryloxycarbonyl, hydroxy, halo,  
alkyl, alkoxy, nitro, thiol, hydroxycarbonyl,  
15 aryloxy, arylthio, aralkyl, aryl, arylcarbonylamino,  
heteroaryloxy, heteroarylthio, heteroaralkyl,  
cycloalkyl, heterocyclooxy, heterocyclothio,  
heterocycloamino, cycloalkyloxy, cycloalkylthio,  
heteroaralkoxy, heteroaralkylthio, aralkoxy,  
20 aralkylthio, aralkylamino, heterocyclo, heteroaryl,  
arylazo, hydroxycarbonylalkoxy, alkoxycarbonylalkoxy,  
alkanoyl, arylcarbonyl, aralkanoyl, alkanoyloxy,  
aralkanoyloxy, hydroxyalkyl, hydroxyalkoxy,  
alkylthio, alkoxyalkylthio, alkoxycarbonyl,  
25 aryloxyalkoxyaryl, arylthioalkylthioaryl,  
aryloxyalkylthioaryl, arylthioalkoxyaryl,  
hydroxycarbonylalkoxy, hydroxycarbonylalkylthio,  
alkoxycarbonylalkoxy, alkoxycarbonylalkylthio, amino,  
wherein the amino nitrogen is (i) unsubstituted,  
30 or (ii) substituted with one or two substituents  
that are independently selected from the group  
consisting of an alkyl, aryl, heteroaryl,  
aralkyl, cycloalkyl, aralkoxycarbonyl,



alkoxycarbonyl, arylcarbonyl, aralkanoyl, heteroarylcarbonyl, heteroaralkanoyl and an alkanoyl group, or (iii) wherein the amino nitrogen and two substituents attached thereto

5 form a 5- to 8-membered heterocyclo or heteroaryl ring containing zero to two additional heteroatoms that are nitrogen, oxygen or sulfur and which ring itself is (a) unsubstituted or (b) substituted with one or two

10 groups independently selected from the group consisting of an aryl, alkyl, heteroaryl, aralkyl, heteroaralkyl, hydroxy, alkoxy, alkanoyl, cycloalkyl, heterocycloalkyl, alkoxy carbonyl, hydroxyalkyl, trifluoromethyl, benzofused heterocycloalkyl, hydroxyalkoxyalkyl,

15 aralkoxy carbonyl, hydroxycarbonyl, aryloxy carbonyl, benzofused heterocycloalkoxy, benzofused cycloalkylcarbonyl, heterocycloalkylcarbonyl, and a cycloalkylcarbonyl group,

20 carbonylamino wherein the carbonylamino nitrogen is (i) unsubstituted, or (ii) is the reacted amine of an amino acid, or (iii) substituted with one or

25 two radicals selected from the group consisting of an alkyl, hydroxyalkyl, hydroxyheteroaralkyl, cycloalkyl, aralkyl, trifluoromethylalkyl, heterocycloalkyl, benzofused heterocycloalkyl, benzofused heterocycloalkyl, benzofused cycloalkyl, and an N,N-dialkylsubstituted

30 alkylamino-alkyl group, or (iv) the carboxamido nitrogen and two substituents bonded thereto together form a 5- to 8-membered heterocyclo, heteroaryl or benzofused heterocycloalkyl ring

that is itself unsubstituted or substituted with one or two radicals independently selected from the group consisting of an alkyl, alkoxy carbonyl, nitro, heterocycloalkyl, hydroxy, hydroxy carbonyl, aryl, aralkyl, heteroaralkyl and an amino group,

wherein the amino nitrogen is (i) unsubstituted, or (ii) substituted with one or two substituents that are independently selected from the group consisting of alkyl, aryl, and heteroaryl, or (iii) wherein the amino nitrogen and two substituents attached thereto form a 5- to 8-membered heterocyclo or heteroaryl ring, and an aminoalkyl group

wherein the aminoalkyl nitrogen is (i) unsubstituted, or (ii) substituted with one or two substituents independently selected from the group consisting of an alkyl, aryl, aralkyl, cycloalkyl, aralkoxy carbonyl, alkoxy carbonyl, and an alkanoyl group, or (iii) wherein the aminoalkyl nitrogen and two substituents attached thereto form a 5- to 8-membered heterocyclo or heteroaryl ring; and

Z is selected group the group consisting of O, S,  $\text{NR}^6$ , SO,  $\text{SO}_2$ , and  $\text{NSO}_2\text{R}^7$ ,

wherein  $\text{R}^6$  is selected from the group consisting of hydrido,  $\text{C}_1\text{-C}_5\text{-alkyl}$ ,  $\text{C}_1\text{-C}_5\text{-alkanoyl}$ , benzyl, benzoyl,  $\text{C}_3\text{-C}_5\text{-alkynyl}$ ,  $\text{C}_3\text{-C}_5\text{-alkenyl}$ ,  $\text{C}_1\text{-C}_3\text{-alkoxy-C}_1\text{-C}_4\text{-alkyl}$ ,  $\text{C}_3\text{-C}_6\text{-cycloalkyl}$ , heteroaryl- $\text{C}_1\text{-C}_6\text{-alkyl}$ ,  $\text{C}_1\text{-C}_5\text{-hydroxyalkyl}$ ,  $\text{C}_1\text{-C}_5\text{-carboxyalkyl}$ ,  $\text{C}_1\text{-}$

C<sub>5</sub>-alkoxy C<sub>1</sub>-C<sub>5</sub>-alkylcarbonyl, and NR<sup>8</sup>R<sup>9</sup>-C<sub>1</sub>-C<sub>5</sub>-alkylcarbonyl or NR<sup>8</sup>R<sup>9</sup>-C<sub>1</sub>-C<sub>5</sub>-alkyl wherein R<sup>8</sup> and R<sup>9</sup> are independently hydrido, C<sub>1</sub>-C<sub>5</sub>-alkyl, C<sub>1</sub>-C<sub>5</sub>-alkoxycarbonyl or aryl-C<sub>1</sub>-C<sub>5</sub>-alkoxycarbonyl, or NR<sup>8</sup>R<sup>9</sup> together form a heterocyclic ring containing 5- to 8-atoms in the ring; and

R<sup>7</sup> is selected from the group consisting of a arylalkyl, aryl, heteroaryl, heterocyclo, C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>6</sub>-alkynyl, C<sub>3</sub>-C<sub>6</sub>-alkenyl, C<sub>1</sub>-C<sub>6</sub>-carboxyalkyl and a C<sub>1</sub>-C<sub>6</sub>-hydroxyalkyl group.

21. The process according to claim 20 wherein R<sup>3</sup> is a single-ringed aryl or heteroaryl group that is 5- or 6-membered, and is itself substituted at its own 4-position when a 6-membered ring or at its own 3- or 4-position when a 5-membered ring with a substituent selected from the group consisting of one other single-ringed aryl or heteroaryl group, a C<sub>3</sub>-C<sub>14</sub> alkyl group, a N-piperidyl group, a N-piperazinyl group, a phenoxy group, a thiophenoxy group, a 4-thiopyridyl group, a phenylazo group and a benzamido group.

22. The process according to claim 20 wherein R<sup>3</sup> has a length that is greater than that of a pentyl group and a length that is less than that of an icosyl group.

23. The process according to claim 20 wherein Z is O, S or NR<sup>6</sup>.

24. The process according to claim 23  
wherein R<sup>6</sup> is selected from the group consisting of  
C<sub>3</sub>-C<sub>6</sub>-cycloalkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-  
5 alkyl, C<sub>3</sub>-C<sub>6</sub>-alkenyl, C<sub>3</sub>-C<sub>6</sub>-alkynyl, amino-C<sub>1</sub>-C<sub>6</sub>-  
alkyl, aminosulfonyl, heteroaryl-C<sub>1</sub>-C<sub>6</sub>-alkyl,  
aryloxycarbonyl, and C<sub>1</sub>-C<sub>6</sub>-alkoxycarbonyl.

25. The process according to claim 20  
10 wherein said R<sup>3</sup> radical is the substituent G-A-R-E-Y,  
wherein G is an aryl or heteroaryl group;  
A is selected from the group consisting of  
(1) -O-;  
(2) -S-;  
15 (3) -NR<sup>17</sup>-;  
(4) -CO-N(R<sup>17</sup>) or -N(R<sup>17</sup>)-CO-, wherein R<sup>17</sup>  
is hydrogen, C<sub>1</sub>-C<sub>4</sub>-alkyl, or phenyl;  
(5) -CO-O- or -O-CO-;  
(6) -O-CO-O-;  
20 (7) -HC=CH-;  
(8) -NH-CO-NH-;  
(9) -C≡C-;  
(10) -NH-CO-O- or -O-CO-NH-;  
(11) -N=N-;  
25 (12) -NH-NH-; and  
(13) -CS-N(R<sup>18</sup>)- or -N(R<sup>18</sup>)-CS-, wherein  
R<sup>18</sup> is hydrogen C<sub>1</sub>-C<sub>4</sub>-alkyl, or  
phenyl; or

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(14) A is absent and G is bonded directly to R;

R is a moiety selected from the group consisting of alkyl, alkoxyalkyl, aryl, heteroaryl, cycloalkyl, heterocycloalkyl, aralkyl, heteroaralkyl, heterocycloalkylalkyl, cycloalkylalkyl, cycloalkoxyalkyl, heterocycloalkoxyalkyl, aryloxyalkyl, heteroaryloxyalkyl, arylthioalkyl, heteroarylthioalkyl, cycloalkylthioalkyl, and a heterocycloalkylthioalkyl group wherein the aryl or heteroaryl or cycloalkyl or heterocycloalkyl substituent is (i) unsubstituted or (ii) substituted with one or two radicals selected from the group consisting of a halo, alkyl, perfluoroalkyl, perfluoroalkoxy, perfluoroalkylthio, trifluoromethylalkyl, amino, alkoxycarbonylalkyl, alkoxy, C<sub>1</sub>-C<sub>2</sub>-alkylene-dioxy, hydroxycarbonylalkyl, hydroxycarbonylalkylamino, nitro, hydroxy, hydroxyalkyl, alkanoylamino, and a alkoxycarbonyl group, and R is other than alkyl or alkoxyalkyl when A is -O- or -S-;

E is selected from the group consisting of

- (1) -CO(R<sup>19</sup>)- or -(R<sup>19</sup>)CO-, wherein R<sup>19</sup> is a heterocycloalkyl, or a cycloalkyl group;
- (2) -CONH- or -HNCO-; and
- (3) -CO-;
- (4) -SO<sub>2</sub>-R<sup>19</sup>- or -R<sup>19</sup>-SO<sub>2</sub>-;
- (5) -SO<sub>2</sub>-;
- (6) -NH-SO<sub>2</sub>- or -SO<sub>2</sub>-NH-; or

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(7) E is absent and R is bonded directly to Y; and

Y is absent or is selected from the group consisting of a hydrido, alkyl, alkoxy, haloalkyl, aryl, aralkyl, cycloalkyl, heteroaryl, hydroxy, aryloxy, aralkoxy, heteroaryloxy, heteroaralkyl, perfluoroalkoxy, perfluoroalkylthio, trifluoromethylalkyl, alkenyl, heterocycloalkyl, cycloalkyl, trifluoromethyl, alkoxycarbonyl, and a aminoalkyl group, wherein the aryl or heteroaryl or heterocycloalkyl group is (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of an alkanoyl, halo, nitro, aralkyl, aryl, alkoxy, and an amino group wherein the amino nitrogen is (i) unsubstituted or (ii) substituted with one or two groups independently selected from hydrido, alkyl, and an aralkyl group.

26. The process according to claim 25 wherein said -G-A-R-E-Y substituent contains two to four carbocyclic or heterocyclic rings.

27. The process according to claim 26 wherein each of the two to four rings is 6-membered.

28. The process according to claim 25 wherein said -G-A-R-E-Y substituent has a length that is greater than a hexyl group and a length that is less than that of a stearyl group.

29. The process according to claim 25 wherein A is -O- or -S-.

30. The process according to claim 25 wherein R is an aryl, heteroaryl, cycloalkyl or heterocycloalkyl group.

31. The process according to claim 25 wherein E is absent.

10

32. The process according to claim 25 wherein Y is selected from the group consisting of hydrido, an alkyl, alkoxy, perfluoroalkoxy and a perfluoroalkylthio group.

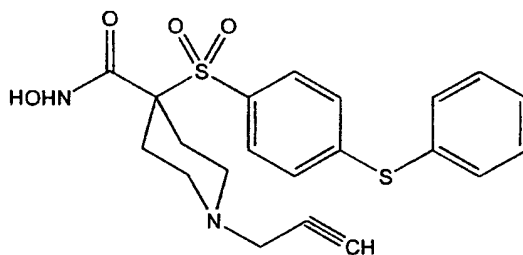
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33. The process according to claim 20 wherein R<sup>3</sup> is a radical that is comprised of a single-ringed aryl or heteroaryl group that is 5- or 6-membered, and is itself substituted at its own 4-position when a 6-membered ring and at its own 3- or 4-position when a 5-membered ring with a substituent selected from the group consisting of a thiophenoxy, 4-chlorophenoxy, 3-chlorophenoxy, 4-methoxyphenoxy, 3-benzodioxol-5-yloxy, 3,4-dimethylphenoxy, 4-fluorophenoxy, 4-fluorothiophenoxy, phenoxy, 4-trifluoromethoxy-phenoxy, 4-trifluoromethylphenoxy, 4-(trifluoromethylthio)-phenoxy, 4-(trifluoromethylthio)-thiophenoxy, 4-chloro-3-fluorophenoxy, 4-isopropoxyphenoxy, 4-isopropylphenoxy, (2-methyl-1,3-benzothiazol-5-yl)oxy, 4-(1H-imidazol-1-yl)phenoxy, 4-chloro-3-methylphenoxy, 3-methylphenoxy, 4-ethoxyphenoxy, 3,4-

20  
25  
30

difluorophenoxy, 4-chloro-3-methylphenoxy, 4-fluoro-  
3-chlorophenoxy, 4-(1H-1,2,4-triazol-1-yl)phenoxy,  
3,5-difluorophenoxy, 3,4-dichlorophenoxy, 4-  
cyclopentylphenoxy, 4-bromo-3-methylphenoxy, 4-  
5 bromophenoxy, 4-methylthiophenoxy, 4-phenylphenoxy,  
4-benzylphenoxy, 6-quinolinyloxy, 4-amino-3-  
methylphenoxy, 3-methoxyphenoxy, 5,6,7,8-tetrahydro-  
2-naphthalenyloxy, 3-hydroxymethylphenoxy, N-  
piperidyl, N-piperazinyl and a 4-benzyloxyphenoxy  
10 group.

34. The process according to claim 20  
wherein said inhibitor corresponds in structure to  
the formula

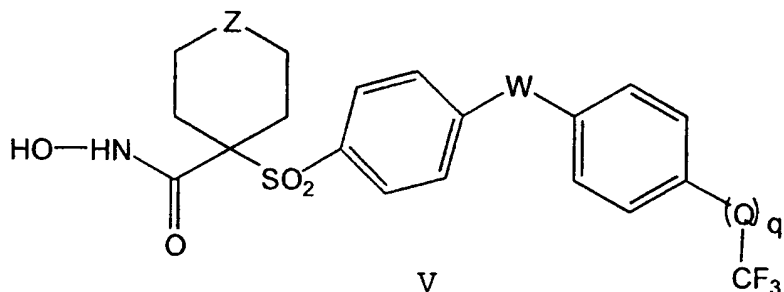


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35. A process for treating a host mammal  
having a condition associated with pathological  
matrix metalloprotease (MMP) activity that comprises  
20 administering a metalloprotease inhibitor compound or  
a pharmaceutically acceptable salt thereof in an  
effective amount to a mammalian host having such a  
condition, said metalloprotease inhibitor inhibiting  
the activity of one or more of MMP-2, MMP-9 and MMP-  
25 13, while exhibiting substantially less inhibitory  
activity against MMP-1, said compound corresponding  
in structure to formula V, below



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wherein

Z is O, S or NR<sup>6</sup>;

5                   W and Q are independently oxygen (O), NR<sup>6</sup>  
or sulfur (S),

R<sup>6</sup> is selected from the group consisting of  
C<sub>3</sub>-C<sub>6</sub>-cycloalkyl, C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>6</sub>-alkenyl, C<sub>3</sub>-C<sub>6</sub>-  
alkynyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, amino-C<sub>1</sub>-C<sub>6</sub>-alkyl,  
10 aminosulfonyl, heteroaryl-C<sub>1</sub>-C<sub>6</sub>-alkyl,  
aryloxycarbonyl, and C<sub>1</sub>-C<sub>6</sub>-alkoxycarbonyl; and

q is zero or one such that when q is zero,  
Q is absent and the trifluoromethyl group is bonded  
directly to the depicted phenyl ring.

15

36. The process according to claim 35  
wherein q is zero.

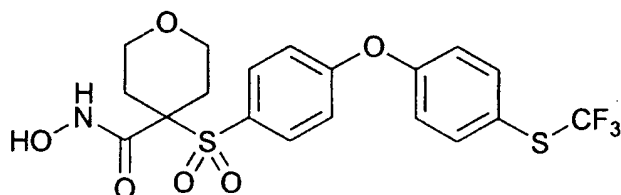
37. The process according to claim 35  
20 wherein W is O.

38. The process according to claim 37  
wherein q is zero.

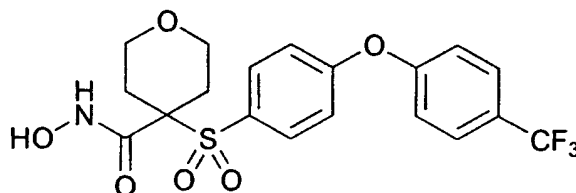
39. The process according to claim 37  
25 wherein q is one and Q is O.

40. The process according to claim 37  
wherein q is one and Q is S.

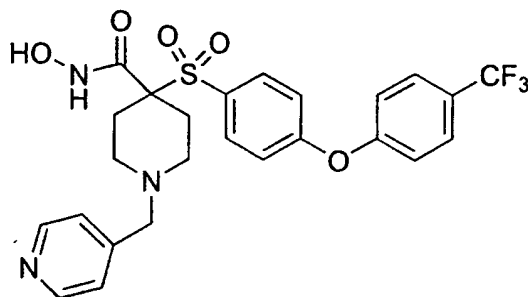
5 41. The process according to claim 35  
wherein said inhibitor corresponds in structure to  
the formula



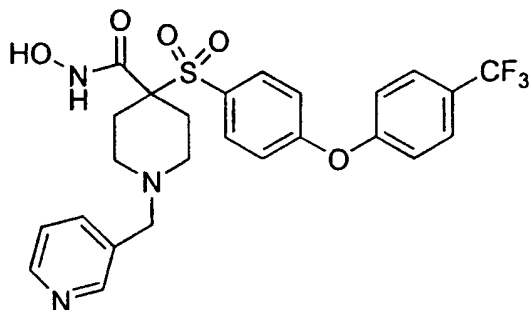
42. The process according to claim 35  
10 wherein said inhibitor corresponds in structure to  
the formula



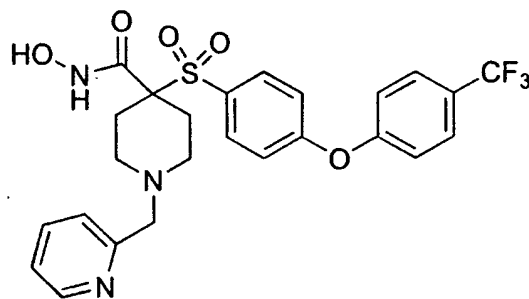
43. The process according to claim 35  
wherein said inhibitor corresponds in structure to  
15 the formula



44. The process according to claim 35  
wherein said inhibitor corresponds in structure to  
the formula

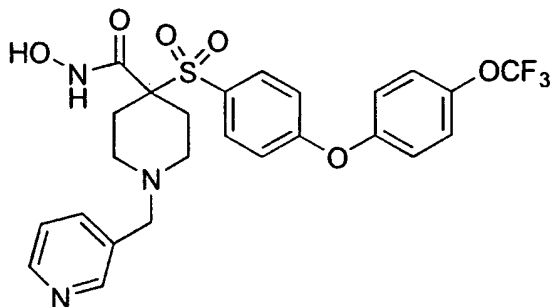


45. The process according to claim 35 wherein said inhibitor corresponds in structure to the formula



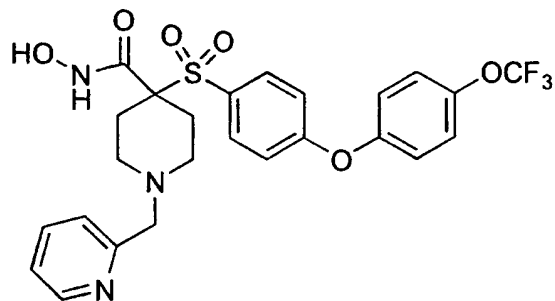
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46. The process according to claim 35 wherein said inhibitor corresponds in structure to the formula

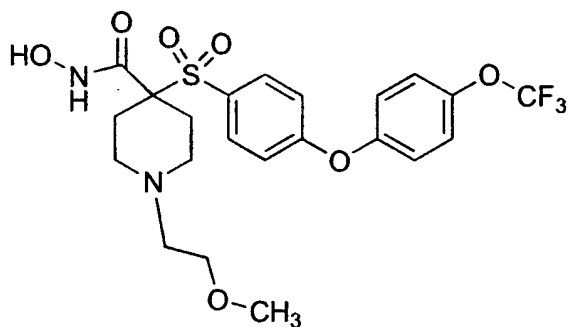


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47. The process according to claim 35 wherein said inhibitor corresponds in structure to the formula

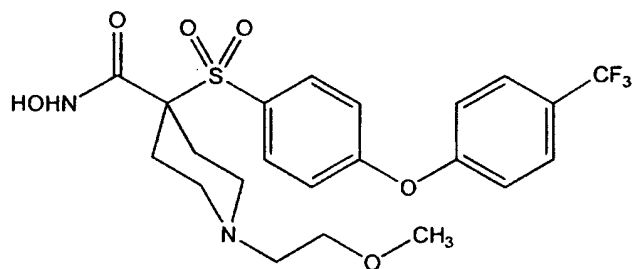


48. The process according to claim 35 wherein said inhibitor corresponds in structure to the formula



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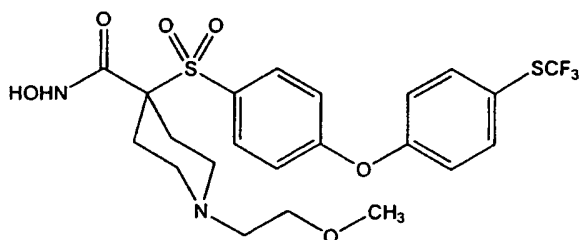
49. The process according to claim 35 wherein said inhibitor corresponds in structure to the formula



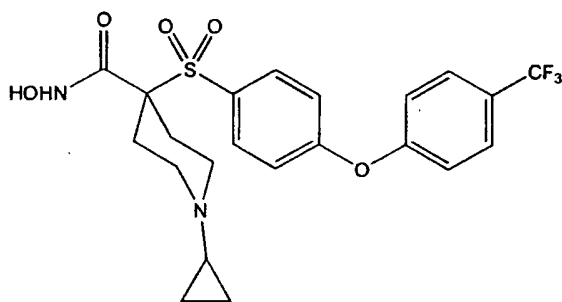
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50. The process according to claim 35 wherein said inhibitor corresponds in structure to the formula

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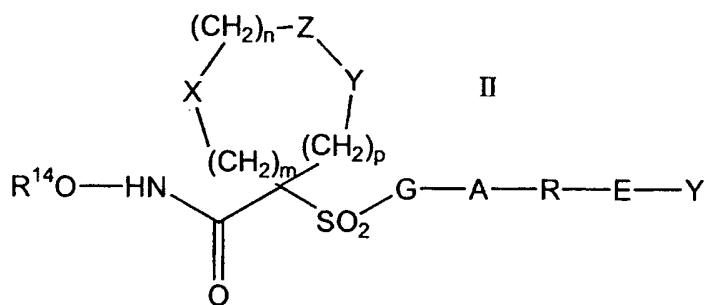


51. The process according to claim 35 wherein said inhibitor corresponds in structure to the formula



5

52. A compound corresponding in structure to formula II, below, or a pharmaceutically acceptable salt thereof:



10

wherein

$R^{14}$  is hydrido, a pharmaceutically acceptable cation or  $C(W)R^{15}$  where  $W$  is O or S and  $R^{15}$  is selected from the group consisting of an  $C_1$ - $C_6$ -alkyl, aryl,  $C_1$ - $C_6$ -alkoxy, heteroaryl- $C_1$ - $C_6$ -alkyl,

15

C<sub>3</sub>-C<sub>8</sub>-cycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, aryloxy, ar-C<sub>1</sub>-C<sub>6</sub>-alkoxy, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryl and amino C<sub>1</sub>-C<sub>6</sub>-alkyl group wherein the aminoalkyl nitrogen is (i) unsubstituted or (ii) substituted with one or two substituents independently selected from the group consisting of an C<sub>1</sub>-C<sub>6</sub>-alkyl, aryl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkoxycarbonyl, C<sub>1</sub>-C<sub>6</sub>-alkoxycarbonyl, and C<sub>1</sub>-C<sub>6</sub>-alkanoyl radical, or (iii) wherein the amino C<sub>1</sub>-C<sub>6</sub>-alkyl nitrogen and two substituents attached thereto form a 5- to 8-membered heterocyclo or heteroaryl ring;

m is zero, 1 or 2;

n is zero, 1 or 2;

15 p is zero, 1 or 2;

the sum of m + n + p = 1, 2, 3 or 4;

(a) one of X, Y and Z is selected from the group consisting of C(O), NR<sup>6</sup>, O, S, S(O), S(O)<sub>2</sub> and NS(O)<sub>2</sub>R<sup>7</sup>, and the remaining two of X, Y and Z are

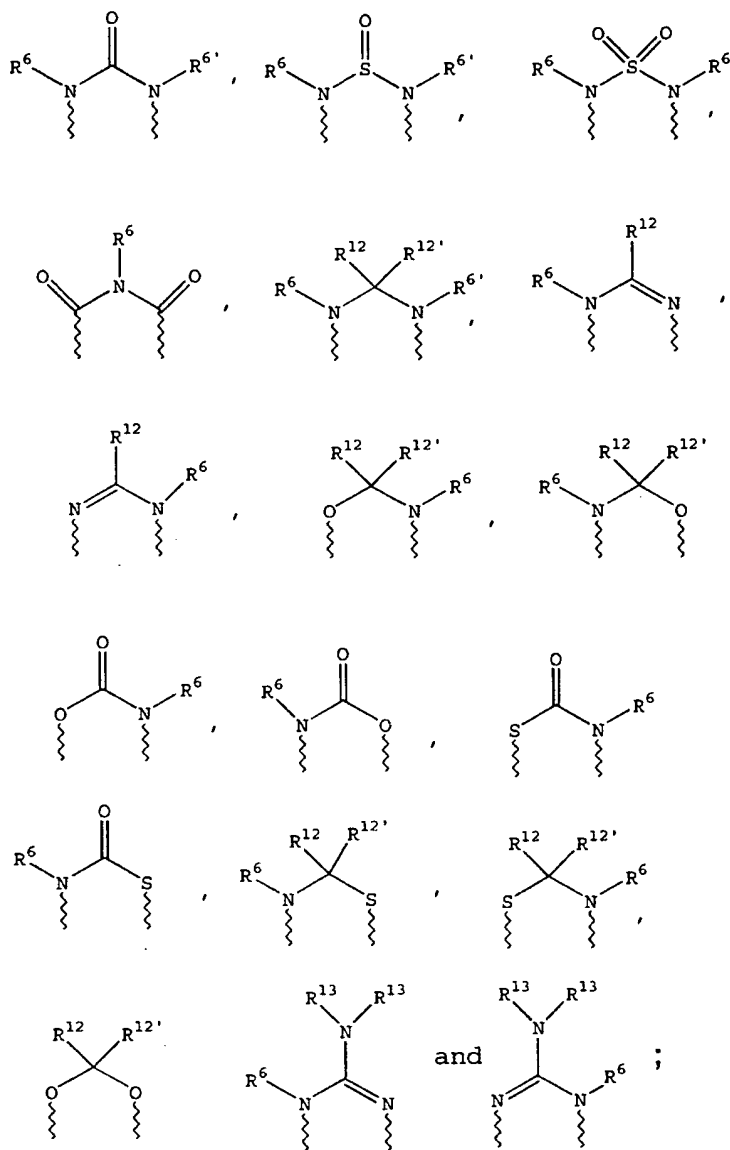
20 CR<sup>8</sup>R<sup>9</sup>, and CR<sup>10</sup>R<sup>11</sup>, or

(b) X and Z or Z and Y together constitute a moiety that is selected from the group consisting of NR<sup>6</sup>C(O), NR<sup>6</sup>S(O), NR<sup>6</sup>S(O)<sub>2</sub>, NR<sup>6</sup>S, NR<sup>6</sup>O, SS, NR<sup>6</sup>NR<sup>6</sup> and OC(O), with the remaining one of X, Y and Z being

25 CR<sup>8</sup>R<sup>9</sup>, or

(c) n is zero and X, Y and Z together constitute a moiety selected from the group consisting of

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5                    wherein wavy lines are bonds to the atoms  
of the depicted ring;

$R^6$  and  $R^{6'}$  are independently selected from  
the group consisting of hydrido,  $C_1$ - $C_6$ -alkanoyl,  $C_6$ -  
aryl- $C_1$ - $C_6$ -alkyl, aroyl, bis( $C_1$ - $C_6$ -alkoxy- $C_1$ - $C_6$ -  
10 alkyl)- $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_6$ -haloalkyl,  $C_1$ -  
 $C_6$ -perfluoroalkyl,  $C_1$ - $C_6$ -trifluoromethylalkyl,  $C_1$ - $C_6$ -

perfluoroalkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>6</sub>-cycloalkyl, C<sub>3</sub>-C<sub>8</sub>-heterocycloalkyl, C<sub>3</sub>-C<sub>8</sub>-heterocycloalkylcarbonyl, C<sub>6</sub>-aryl, C<sub>5</sub>-C<sub>6</sub>-heterocyclo, C<sub>5</sub>-C<sub>6</sub>-heteroaryl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>6</sub>-aryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryl-C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroarylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>6</sub>-arylsulfonyl, C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl, C<sub>5</sub>-C<sub>6</sub>-heteroarylsulfonyl, carboxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>4</sub>-alkoxycarbonyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, aminocarbonyl, C<sub>1</sub>-C<sub>6</sub>-alkyliminocarbonyl, C<sub>6</sub>-aryliminocarbonyl, C<sub>5</sub>-C<sub>6</sub>-heterocycloiminocarbonyl, C<sub>6</sub>-arylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>6</sub>-arylthio-C<sub>3</sub>-C<sub>6</sub>-alkenyl, C<sub>1</sub>-C<sub>4</sub>-alkylthio-C<sub>3</sub>-C<sub>6</sub>-alkenyl, C<sub>5</sub>-C<sub>6</sub>-heteroaryl-C<sub>1</sub>-C<sub>6</sub>-alkyl, halo-C<sub>1</sub>-C<sub>6</sub>-alkanoyl, hydroxy-C<sub>1</sub>-C<sub>6</sub>-alkanoyl, thiol-C<sub>1</sub>-C<sub>6</sub>-alkanoyl, C<sub>3</sub>-C<sub>6</sub>-alkenyl, C<sub>3</sub>-C<sub>6</sub>-alkynyl, C<sub>1</sub>-C<sub>4</sub>-alkoxy-C<sub>1</sub>-C<sub>4</sub>-alkyl, C<sub>1</sub>-C<sub>5</sub>-alkoxycarbonyl, aryloxycarbonyl, NR<sup>8</sup>R<sup>9</sup>-C<sub>1</sub>-C<sub>5</sub>-alkylcarbonyl, hydroxy-C<sub>1</sub>-C<sub>5</sub>-alkyl, an aminocarbonyl wherein the aminocarbonyl nitrogen is (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl and a C<sub>1</sub>-C<sub>6</sub>-alkanoyl group, hydroxyaminocarbonyl, an aminosulfonyl group wherein the aminosulfonyl nitrogen is (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl and a



C<sub>1</sub>-C<sub>6</sub>-alkanoyl group, an amino-C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl group wherein the amino-C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl nitrogen is (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl and a C<sub>1</sub>-C<sub>6</sub>-alkanoyl group and an amino-C<sub>1</sub>-C<sub>6</sub>-alkyl group wherein the aminoalkyl nitrogen is (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl and a C<sub>1</sub>-C<sub>6</sub>-alkanoyl group;

R<sup>7</sup> is selected from the group consisting of a arylalkyl, aryl, heteroaryl, heterocyclo, C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>6</sub>-alkynyl, C<sub>3</sub>-C<sub>6</sub>-alkenyl, C<sub>1</sub>-C<sub>6</sub>-carboxyalkyl and a C<sub>1</sub>-C<sub>6</sub>-hydroxyalkyl group;

R<sup>8</sup> and R<sup>9</sup> and R<sup>10</sup> and R<sup>11</sup> are independently selected from the group consisting of a hydrido, hydroxy, C<sub>1</sub>-C<sub>6</sub>-alkyl, aryl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryl, heteroar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>2</sub>-C<sub>6</sub>-alkynyl, C<sub>2</sub>-C<sub>6</sub>-alkenyl, thiol-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl cycloalkyl, cycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, heterocycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, aralkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxycarbonyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxycarbonylar-C<sub>1</sub>-C<sub>6</sub>-alkyl, aminocarbonyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, aryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, arylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroarylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, the sulfoxide or

sulfone of any said thio substituents, perfluoro-C<sub>1</sub>-C<sub>6</sub>-alkyl, trifluoromethyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, halo-C<sub>1</sub>-C<sub>6</sub>-alkyl, alkoxycarbonylamino-C<sub>1</sub>-C<sub>6</sub>-alkyl and an amino-C<sub>1</sub>-C<sub>6</sub>-alkyl group wherein the aminoalkyl nitrogen is

5 (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, cycloalkyl and C<sub>1</sub>-C<sub>6</sub>-alkanoyl, or wherein R<sup>8</sup> and R<sup>9</sup> or R<sup>10</sup> and R<sup>11</sup> and the carbon to which they are bonded form a

10 carbonyl group, or wherein R<sup>8</sup> and R<sup>9</sup> or R<sup>10</sup> and R<sup>11</sup>, or R<sup>8</sup> and R<sup>10</sup> together with the atoms to which they are bonded form a 5- to 8-membered carbocyclic ring, or a 5- to 8-membered heterocyclic ring containing one or two heteroatoms that are nitrogen, oxygen, or

15 sulfur, with the proviso that only one of R<sup>8</sup> and R<sup>9</sup> or R<sup>10</sup> and R<sup>11</sup> is hydroxy;

R<sup>12</sup> and R<sup>12'</sup> are independently selected from the group consisting of a hydrido, C<sub>1</sub>-C<sub>6</sub>-alkyl, aryl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryl, heteroaralkyl, C<sub>2</sub>-C<sub>6</sub>-alkynyl, C<sub>2</sub>-C<sub>6</sub>-alkenyl, thiol-C<sub>1</sub>-C<sub>6</sub>-alkyl,

20 cycloalkyl, cycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, heterocycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, aryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, amino-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxycarbonyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxycarbonylar-C<sub>1</sub>-C<sub>6</sub>-alkyl,

25 aminocarbonyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, aryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, arylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroarylthio-C<sub>1</sub>-C<sub>6</sub>-

alkyl, the sulfoxide or sulfone of any said thio  
substituents, perfluoro-C<sub>1</sub>-C<sub>6</sub>-alkyl, trifluoromethyl-  
C<sub>1</sub>-C<sub>6</sub>-alkyl, halo-C<sub>1</sub>-C<sub>6</sub>-alkyl, alkoxycarbonylamino-  
C<sub>1</sub>-C<sub>6</sub>-alkyl and an amino-C<sub>1</sub>-C<sub>6</sub>-alkyl group wherein  
5 the aminoalkyl nitrogen is (i) unsubstituted or (ii)  
substituted with one or two radicals independently  
selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl,  
ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, cycloalkyl and C<sub>1</sub>-C<sub>6</sub>-alkanoyl;

R<sup>13</sup> is selected from the group consisting  
10 of a hydrido, benzyl, phenyl, C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>2</sub>-C<sub>6</sub>-  
alkynyl, C<sub>2</sub>-C<sub>6</sub>-alkenyl and a C<sub>1</sub>-C<sub>6</sub>-hydroxyalkyl  
group; and

G-A-R-E-Y is a substituent that has a  
length greater than that of a pentyl group a length  
15 that is less than that of an icosyl group, and  
wherein

G is an aryl or heteroaryl group;

A is selected from the group consisting of

- 20 (1) -O-;  
(2) -S-;  
(3) -NR<sup>17</sup>-;  
(4) -CO-N(R<sup>17</sup>) or -N(R<sup>17</sup>)-CO-, wherein R<sup>17</sup>  
is hydrogen, C<sub>1</sub>-C<sub>4</sub>-alkyl, or phenyl;  
(5) -CO-O- or -O-CO-;  
25 (6) -O-CO-O-;  
(7) -HC=CH-;  
(8) -NH-CO-NH-;  
(9) -C≡C-;  
(10) -NH-CO-O- or -O-CO-NH-;

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(11) -N=N-;

(12) -NH-NH-; and

(13) -CS-N(R<sup>18</sup>)- or -N(R<sup>18</sup>)-CS-, whereinR<sup>18</sup> is hydrogen C<sub>1</sub>-C<sub>4</sub>-alkyl, or

5 phenyl; or

(14) A is absent and G is bonded directly to R;

R is a moiety selected from the group consisting of alkyl, alkoxyalkyl, aryl, heteroaryl, cycloalkyl, heterocycloalkyl, aralkyl, heteroaralkyl, heterocycloalkylalkyl, cycloalkylalkyl, cycloalkoxyalkyl, heterocycloalkoxyalkyl, aryloxyalkyl, heteroaryloxyalkyl, arylthioalkyl, heteroarylthioalkyl, cycloalkylthioalkyl, and a

10 heterocycloalkylthioalkyl group wherein the aryl or heteroaryl or cycloalkyl or heterocycloalkyl substituent is (i) unsubstituted or (ii) substituted with one or two radicals selected from the group consisting of a halo, alkyl, perfluoroalkyl, perfluoroalkoxy, perfluoroalkylthio,

20 trifluoromethylalkyl, amino, alkoxycarbonylalkyl, alkoxy, C<sub>1</sub>-C<sub>2</sub>-alkylene-dioxy, hydroxycarbonylalkyl, hydroxycarbonylalkylamino, nitro, hydroxy, hydroxyalkyl, alkanoylamino, and a alkoxycarbonyl

25 group, and R is other than alkyl or alkoxyalkyl when A is -O- or -S-;

E is selected from the group consisting of

(1) -CO(R<sup>19</sup>)- or -(R<sup>19</sup>)CO-, wherein R<sup>19</sup> is a heterocycloalkyl, or a cycloalkyl

30 group;

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- (2) -CONH- or -HNCO-; and  
(3) -CO-;  
(4) -SO<sub>2</sub>-R<sup>19</sup>- or -R<sup>19</sup>-SO<sub>2</sub>-;  
(5) -SO<sub>2</sub>-;  
5 (6) -NH-SO<sub>2</sub>- or -SO<sub>2</sub>-NH-; or  
(7) E is absent and R is bonded directly  
to Y; and

Y is absent or is selected from the group  
consisting of a hydrido, alkyl, alkoxy, haloalkyl,  
10 aryl, aralkyl, cycloalkyl, heteroaryl, hydroxy,  
aryloxy, aralkoxy, heteroaryloxy, heteroaralkyl,  
perfluoroalkoxy, perfluoroalkylthio,  
trifluoromethylalkyl, alkenyl, heterocycloalkyl,  
cycloalkyl, trifluoromethyl, alkoxycarbonyl, and a  
15 aminoalkyl group, wherein the aryl or heteroaryl or  
heterocycloalkyl group is (i) unsubstituted or (ii)  
substituted with one or two radicals independently  
selected from the group consisting of an alkanoyl,  
halo, nitro, aralkyl, aryl, alkoxy, and an amino  
20 group wherein the amino nitrogen is (i) unsubstituted  
or (ii) substituted with one or two groups  
independently selected from hydrido, alkyl, and an  
aralkyl group.

25 53. The compound or salt according to  
claim 52 wherein said -G-A-R-E-Y substituent contains  
two to four carbocyclic or heterocyclic rings.

30 54. The compound or salt according to  
claim 52 wherein each of the two to four rings is 6-  
membered.

55. The compound or salt according to claim 52 wherein said -G-A-R-E-Y substituent has a length that is greater than a hexyl group and a  
5 length that is less than that of a stearyl group.

56. The compound or salt according to claim 52 wherein A is -O- or -S-.

10 57. The compound or salt according to claim 52 wherein R is an aryl, heteroaryl, cycloalkyl or heterocycloalkyl group.

58. The compound or salt according to  
15 claim 52 wherein E is absent.

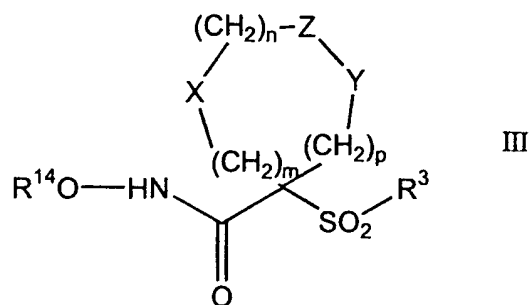
59. The compound or salt according to claim 52 wherein Y is selected from the group consisting of hydrido, an alkyl, alkoxy,  
20 perfluoroalkoxy and a perfluoroalkylthio group.

60. The compound or salt according to claim 52 wherein  $R^{14}$  is hydrido.

25 61. The compound or salt according to claim 52 wherein W of the  $C(W)R^{15}$  is O and  $R^{15}$  is a  $C_1$ - $C_6$ -alkyl, aryl,  $C_1$ - $C_6$ -alkoxy, heteroaryl- $C_1$ - $C_6$ -alkyl,  $C_3$ - $C_8$ -cycloalkyl- $C_1$ - $C_6$ -alkyl, or aryloxy group.

30

62. A compound corresponding in structure to formula III, below, or a pharmaceutically acceptable salt thereof



5

wherein

$R^3$  is a single-ringed aryl or heteroaryl group that is 5- or 6-membered, and is itself substituted at its own 4-position when a 6-membered ring and at its own 3- or 4-position when a 5-membered ring with a substituent selected from the group consisting of a thiophenoxy, 4-chloro-phenoxy, 3-chlorophenoxy, 4-methoxyphenoxy, 3-benzodioxol-5-yloxy, 3,4-dimethylphenoxy, 4-fluorophenoxy, 4-fluorothiophenoxy, phenoxy, 4-trifluoromethoxyphenoxy, 4-trifluoromethylphenoxy, 4-(trifluoromethylthio)phenoxy, 4-(trifluoromethylthio)thiophenoxy, 4-chloro-3-fluorophenoxy, 4-isopropoxyphenoxy, 4-isopropylphenoxy, (2-methyl-1,3-benzothiazol-5-yl)oxy, 4-(1H-imidazol-1-yl)phenoxy, 4-chloro-3-methylphenoxy, 3-methyl-phenoxy, 4-ethoxyphenoxy, 3,4-difluorophenoxy, 4-chloro-3-methylphenoxy, 4-fluoro-3-chlorophenoxy, 4-(1H-1,2,4-triazol-1-yl)phenoxy, 3,5-difluorophenoxy, 3,4-dichlorophenoxy, 4-cyclopentylphenoxy, 4-bromo-3-methylphenoxy, 4-bromophenoxy, 4-methylthiophenoxy,

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4-phenylphenoxy, 4-benzylphenoxy, 6-quinolinyloxy, 4-amino-3-methylphenoxy, 3-methoxyphenoxy, 5,6,7,8-tetrahydro-2-naphthalenyloxy, 3-hydroxymethylphenoxy, and a 4-benzyloxyphenoxy group;

5  $R^{14}$  is hydrido, a pharmaceutically acceptable cation or  $C(W)R^{15}$  where W is O or S and  $R^{15}$  is selected from the group consisting of a  $C_1-C_6$ -alkyl, aryl,  $C_1-C_6$ -alkoxy, heteroaryl- $C_1-C_6$ -alkyl,  $C_3-C_8$ -cycloalkyl- $C_1-C_6$ -alkyl, aryloxy, ar- $C_1-C_6$ -  
10 alkoxy, ar- $C_1-C_6$ -alkyl, heteroaryl and amino  $C_1-C_6$ -alkyl group wherein the aminoalkyl nitrogen is (i) unsubstituted or (ii) substituted with one or two substituents independently selected from the group consisting of an  $C_1-C_6$ -alkyl, aryl, ar- $C_1-C_6$ -alkyl,  
15  $C_3-C_8$ -cycloalkyl- $C_1-C_6$ -alkyl, ar- $C_1-C_6$ -alkoxycarbonyl,  $C_1-C_6$ -alkoxycarbonyl, and  $C_1-C_6$ -alkanoyl radical, or (iii) wherein the amino  $C_1-C_6$ -alkyl nitrogen and two substituents attached thereto form a 5- to 8-membered heterocyclo or heteroaryl  
20 ring;

m is zero, 1 or 2;

n is zero, 1 or 2;

p is zero, 1 or 2;

the sum of  $m + n + p = 1, 2, 3$  or 4;

25 (a) one of X, Y and Z is selected from the group consisting of  $C(O)$ ,  $NR^6$ , O, S,  $S(O)$ ,  $S(O)_2$  and  $NS(O)_2R^7$ , and the remaining two of X, Y and Z are  $CR^8R^9$ , and  $CR^{10}R^{11}$ , or

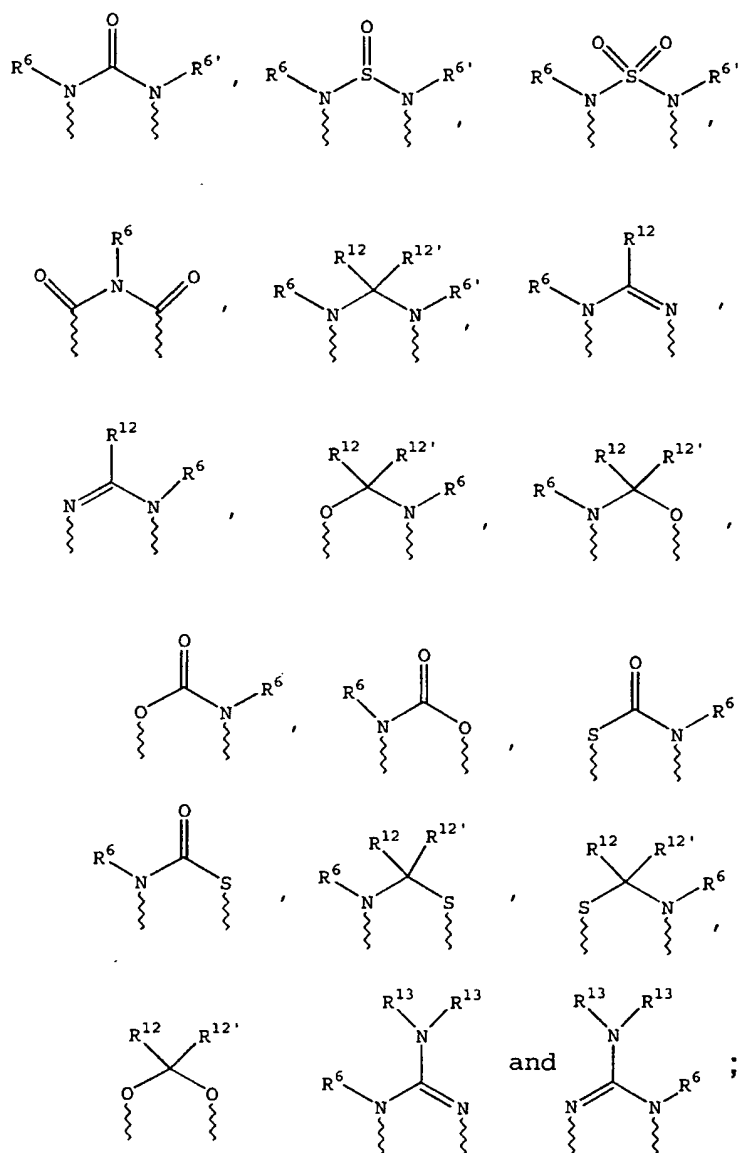
(b) X and Z or Z and Y together  
30 constitute a moiety that is selected from the group



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consisting of  $\text{NR}^6\text{C}(\text{O})$ ,  $\text{NR}^6\text{S}(\text{O})$ ,  $\text{NR}^6\text{S}(\text{O})_2$ ,  $\text{NR}^6\text{S}$ ,  $\text{NR}^6\text{O}$ ,  
 $\text{SS}$ ,  $\text{NR}^6\text{NR}^6$  and  $\text{OC}(\text{O})$ , with the remaining one of X, Y  
 and Z being  $\text{CR}^8\text{R}^9$ , or

- (c) n is zero and X, Y and Z together  
 5 constitute a moiety selected from the group  
 consisting of



wherein wavy lines are bonds to the atoms of the depicted ring;

$R^6$  and  $R^{6'}$  are independently selected from the group consisting of hydrido,  $C_1$ - $C_6$ -alkanoyl,  $C_6$ -aryl- $C_1$ - $C_6$ -alkyl, aroyl, bis( $C_1$ - $C_6$ -alkoxy- $C_1$ - $C_6$ -alkyl)- $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_6$ -haloalkyl,  $C_1$ - $C_6$ -perfluoroalkyl,  $C_1$ - $C_6$ -trifluoromethylalkyl,  $C_1$ - $C_6$ -perfluoroalkoxy- $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_6$ -alkoxy- $C_1$ - $C_6$ -alkyl,  $C_3$ - $C_6$ -cycloalkyl,  $C_3$ - $C_8$ -heterocycloalkyl,  $C_3$ - $C_8$ -heterocycloalkylcarbonyl,  $C_6$ -aryl,  $C_5$ - $C_6$ -heterocyclo,  $C_5$ - $C_6$ -heteroaryl,  $C_3$ - $C_8$ -cycloalkyl- $C_1$ - $C_6$ -alkyl,  $C_6$ -aryloxy- $C_1$ - $C_6$ -alkyl, heteroaryloxy- $C_1$ - $C_6$ -alkyl, heteroaryl- $C_1$ - $C_6$ -alkoxy- $C_1$ - $C_6$ -alkyl, heteroarylthio- $C_1$ - $C_6$ -alkyl,  $C_6$ -arylsulfonyl,  $C_1$ - $C_6$ -alkylsulfonyl,  $C_5$ - $C_6$ -heteroarylsulfonyl, carboxy- $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_4$ -alkoxycarbonyl- $C_1$ - $C_6$ -alkyl, aminocarbonyl,  $C_1$ - $C_6$ -alkyliminocarbonyl,  $C_6$ -aryliminocarbonyl,  $C_5$ - $C_6$ -heterocycloiminocarbonyl,  $C_6$ -arylthio- $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_6$ -alkylthio- $C_1$ - $C_6$ -alkyl,  $C_6$ -arylthio- $C_3$ - $C_6$ -alkenyl,  $C_1$ - $C_4$ -alkylthio- $C_3$ - $C_6$ -alkenyl,  $C_5$ - $C_6$ -heteroaryl- $C_1$ - $C_6$ -alkyl, halo- $C_1$ - $C_6$ -alkanoyl, hydroxy- $C_1$ - $C_6$ -alkanoyl, thiol- $C_1$ - $C_6$ -alkanoyl,  $C_3$ - $C_6$ -alkenyl,  $C_3$ - $C_6$ -alkynyl,  $C_1$ - $C_4$ -alkoxy- $C_1$ - $C_4$ -alkyl,  $C_1$ - $C_5$ -alkoxycarbonyl, aryloxycarbonyl,  $NR^{8R^9}$ - $C_1$ - $C_5$ -alkylcarbonyl, hydroxy- $C_1$ - $C_5$ -alkyl, an aminocarbonyl wherein the aminocarbonyl nitrogen is (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group

consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl and a C<sub>1</sub>-C<sub>6</sub>-alkanoyl group,  
hydroxyaminocarbonyl, an aminosulfonyl group wherein the aminosulfonyl nitrogen is (i) unsubstituted or  
5 (ii) substituted with one or two radicals independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl and a C<sub>1</sub>-C<sub>6</sub>-alkanoyl group, an amino-C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl group wherein the amino-C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl nitrogen  
10 is (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl and a C<sub>1</sub>-C<sub>6</sub>-alkanoyl group and an amino-C<sub>1</sub>-C<sub>6</sub>-alkyl group wherein the aminoalkyl nitrogen is  
15 (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl and a C<sub>1</sub>-C<sub>6</sub>-alkanoyl group;

R<sup>7</sup> is selected from the group consisting of  
20 a arylalkyl, aryl, heteroaryl, heterocyclo, C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>6</sub>-alkynyl, C<sub>3</sub>-C<sub>6</sub>-alkenyl, C<sub>1</sub>-C<sub>6</sub>-carboxyalkyl and a C<sub>1</sub>-C<sub>6</sub>-hydroxyalkyl group;

R<sup>8</sup> and R<sup>9</sup> and R<sup>10</sup> and R<sup>11</sup> are independently selected from the group consisting of a hydrido,  
25 hydroxy, C<sub>1</sub>-C<sub>6</sub>-alkyl, aryl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryl, heteroar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>2</sub>-C<sub>6</sub>-alkynyl, C<sub>2</sub>-C<sub>6</sub>-alkenyl, thiol-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl cycloalkyl, cycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, heterocycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-

- alkyl, aralkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxycarbonyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxycarbonylar-C<sub>1</sub>-C<sub>6</sub>-alkyl, aminocarbonyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, aryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, arylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroarylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, the sulfoxide or sulfone of any said thio substituents, perfluoro-C<sub>1</sub>-C<sub>6</sub>-alkyl, trifluoromethyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, halo-C<sub>1</sub>-C<sub>6</sub>-alkyl, alkoxycarbonylamino-C<sub>1</sub>-C<sub>6</sub>-alkyl and an amino-C<sub>1</sub>-C<sub>6</sub>-alkyl group wherein the aminoalkyl nitrogen is (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, cycloalkyl and C<sub>1</sub>-C<sub>6</sub>-alkanoyl, or wherein R<sup>8</sup> and R<sup>9</sup> or R<sup>10</sup> and R<sup>11</sup> and the carbon to which they are bonded form a carbonyl group, or wherein R<sup>8</sup> and R<sup>9</sup> or R<sup>10</sup> and R<sup>11</sup>, or R<sup>8</sup> and R<sup>10</sup> together with the atoms to which they are bonded form a 5- to 8-membered carbocyclic ring, or a 5- to 8-membered heterocyclic ring containing one or two heteroatoms that are nitrogen, oxygen, or sulfur, with the proviso that only one of R<sup>8</sup> and R<sup>9</sup> or R<sup>10</sup> and R<sup>11</sup> is hydroxy;

R<sup>12</sup> and R<sup>12'</sup> are independently selected from the group consisting of a hydrido, C<sub>1</sub>-C<sub>6</sub>-alkyl, aryl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryl, heteroaralkyl, C<sub>2</sub>-C<sub>6</sub>-alkynyl, C<sub>2</sub>-C<sub>6</sub>-alkenyl, thiol-C<sub>1</sub>-C<sub>6</sub>-alkyl, cycloalkyl, cycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, heterocycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, aryloxy-C<sub>1</sub>-C<sub>6</sub>-

alkyl, amino-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxycarbonyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxycarbonylar-C<sub>1</sub>-C<sub>6</sub>-alkyl, aminocarbonyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, aryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, arylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroarylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, the sulfoxide or sulfone of any said thio substituents, perfluoro-C<sub>1</sub>-C<sub>6</sub>-alkyl, trifluoromethyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, halo-C<sub>1</sub>-C<sub>6</sub>-alkyl, alkoxycarbonylamino-C<sub>1</sub>-C<sub>6</sub>-alkyl and an amino-C<sub>1</sub>-C<sub>6</sub>-alkyl group wherein the aminoalkyl nitrogen is (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, cycloalkyl and C<sub>1</sub>-C<sub>6</sub>-alkanoyl; and R<sup>13</sup> is selected from the group consisting of a hydrido, benzyl, phenyl, C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>2</sub>-C<sub>6</sub>-alkynyl, C<sub>2</sub>-C<sub>6</sub>-alkenyl and a C<sub>1</sub>-C<sub>6</sub>-hydroxyalkyl group.

63. The compound or salt according to claim 62 wherein the sum of  $m + n + p = 1$  or  $2$ .

64. The compound or salt according to claim 62 wherein Z is O, S or NR<sup>6</sup>.

65. The compound or salt according to claim 62 wherein R<sup>6</sup> is selected from the group consisting of C<sub>3</sub>-C<sub>6</sub>-cycloalkyl, C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>6</sub>-alkenyl, C<sub>3</sub>-C<sub>6</sub>-alkynyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl,

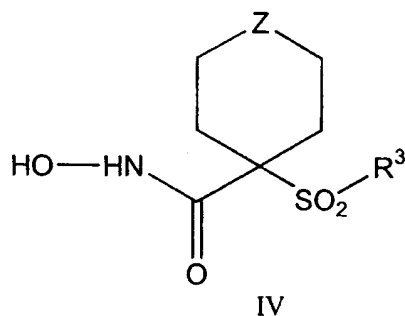
amino-C<sub>1</sub>-C<sub>6</sub>-alkyl, aminosulfonyl, heteroaryl-C<sub>1</sub>-C<sub>6</sub>-alkyl, aryloxy carbonyl, and C<sub>1</sub>-C<sub>6</sub>-alkoxycarbonyl.

66. The compound or salt according to claim 62 wherein m = n = zero, p = 1, and Y is NR<sup>6</sup>.

5 67. The compound or salt according to claim 62 wherein R<sup>14</sup> is hydrido.

68. The compound or salt according to claim 62 wherein W of the C(W)R<sup>15</sup> is O and R<sup>15</sup> is a  
10 C<sub>1</sub>-C<sub>6</sub>-alkyl, aryl, C<sub>1</sub>-C<sub>6</sub>-alkoxy, heteroaryl-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, or aryloxy group.

69. A compound corresponding in structure  
15 to formula IV, below, or a pharmaceutically acceptable salt thereof



wherein R<sup>3</sup> is a single-ringed aryl or  
20 heteroaryl group that is 5- or 6-membered, and is itself substituted at its own 4-position when a 6-membered ring or at its own 3- or 4-position when a 5-membered ring with a substituent selected from the group consisting of one other single-ringed aryl or  
25 heteroaryl group, a C<sub>3</sub>-C<sub>14</sub> alkyl group, a N-piperidyl

group, a N-piperazinyl group, a phenoxy group, a thiophenoxy group, a 4-thiopyridyl group, a phenylazo group and a benzamido group; and

Z is selected group the group consisting of  
5 O, S, NR<sup>6</sup>, SO, SO<sub>2</sub>, and NSO<sub>2</sub>R<sup>7</sup>,

wherein R<sup>6</sup> is selected from the group consisting of hydrido, C<sub>1</sub>-C<sub>5</sub>-alkyl, C<sub>1</sub>-C<sub>5</sub>-alkanoyl, benzyl, benzoyl, C<sub>3</sub>-C<sub>5</sub>-alkynyl, C<sub>3</sub>-C<sub>5</sub>-alkenyl, C<sub>1</sub>-C<sub>3</sub>-alkoxy-C<sub>1</sub>-C<sub>4</sub>-alkyl, C<sub>3</sub>-C<sub>6</sub>-cycloalkyl, heteroaryl-C<sub>1</sub>-  
10 C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>5</sub>-hydroxyalkyl, C<sub>1</sub>-C<sub>5</sub>-carboxyalkyl, C<sub>1</sub>-C<sub>5</sub>-alkoxy C<sub>1</sub>-C<sub>5</sub>-alkylcarbonyl, and NR<sup>8</sup>R<sup>9</sup>-C<sub>1</sub>-C<sub>5</sub>-alkylcarbonyl or NR<sup>8</sup>R<sup>9</sup>-C<sub>1</sub>-C<sub>5</sub>-alkyl wherein R<sup>8</sup> and R<sup>9</sup> are independently hydrido, C<sub>1</sub>-C<sub>5</sub>-alkyl, C<sub>1</sub>-C<sub>5</sub>-alkoxycarbonyl or aryl-C<sub>1</sub>-C<sub>5</sub>-alkoxycarbonyl, or NR<sup>8</sup>R<sup>9</sup>  
15 together form a heterocyclic ring containing 5- to 8-atoms in the ring; and

R<sup>7</sup> is selected from the group consisting of a arylalkyl, aryl, heteroaryl, heterocyclo, C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>6</sub>-alkynyl, C<sub>3</sub>-C<sub>6</sub>-alkenyl, C<sub>1</sub>-C<sub>6</sub>-  
20 carboxyalkyl and a C<sub>1</sub>-C<sub>6</sub>-hydroxyalkyl group.

70. The compound or salt according to claim 69 wherein R<sup>3</sup> has a length that is greater than that of a pentyl group and a length that is less than  
25 that of an icosyl group.

71. The compound or salt according to claim 69 wherein Z is O, S or NR<sup>6</sup>.

72. The compound or salt according to claim 69 wherein  $R^6$  is selected from the group consisting of  $C_3$ - $C_6$ -cycloalkyl,  $C_1$ - $C_6$ -alkoxy- $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_6$ -alkyl,  $C_3$ - $C_6$ -alkenyl,  $C_3$ - $C_6$ -alkynyl, amino- $C_1$ - $C_6$ -alkyl, aminosulfonyl, heteroaryl- $C_1$ - $C_6$ -alkyl, aryloxy carbonyl, and  $C_1$ - $C_6$ -alkoxycarbonyl.

73. The compound or salt according to claim 69 wherein said  $R^3$  radical is the substituent G-A-R-E-Y, wherein

G is an aryl or heteroaryl group;

A is selected from the group

consisting of

- (1) -O-;
- (2) -S-;
- (3) -NR<sup>17</sup>-;
- (4) -CO-N(R<sup>17</sup>) or -N(R<sup>17</sup>)-CO-, wherein R<sup>17</sup> is hydrogen,  $C_1$ - $C_4$ -alkyl, or phenyl;
- (5) -CO-O- or -O-CO-;
- (6) -O-CO-O-;
- (7) -HC=CH-;
- (8) -NH-CO-NH-;
- (9) -C≡C-;
- (10) -NH-CO-O- or -O-CO-NH-;
- (11) -N=N-;
- (12) -NH-NH-; and
- (13) -CS-N(R<sup>18</sup>)- or -N(R<sup>18</sup>)-CS-, wherein R<sup>18</sup> is hydrogen  $C_1$ - $C_4$ -alkyl, or phenyl; or



(14) A is absent and G is bonded directly to R;

R is a moiety selected from the group consisting of alkyl, alkoxyalkyl, aryl, heteroaryl, cycloalkyl, heterocycloalkyl, aralkyl, heteroaralkyl, heterocycloalkylalkyl, cycloalkylalkyl, cycloalkoxyalkyl, heterocycloalkoxyalkyl, aryloxyalkyl, heteroaryloxyalkyl, arylthioalkyl, heteroarylthioalkyl, cycloalkylthioalkyl, and a heterocycloalkylthioalkyl group wherein the aryl or heteroaryl or cycloalkyl or heterocycloalkyl substituent is (i) unsubstituted or (ii) substituted with one or two radicals selected from the group consisting of a halo, alkyl, perfluoroalkyl, perfluoroalkoxy, perfluoroalkylthio, trifluoromethylalkyl, amino, alkoxycarbonylalkyl, alkoxy, C<sub>1</sub>-C<sub>2</sub>-alkylene-dioxy, hydroxycarbonylalkyl, hydroxycarbonylalkylamino, nitro, hydroxy, hydroxyalkyl, alkanoylamino, and a alkoxycarbonyl group, and R is other than alkyl or alkoxyalkyl when A is -O- or -S-;

E is selected from the group consisting of

- (1) -CO(R<sup>19</sup>)- or -(R<sup>19</sup>)CO-, wherein R<sup>19</sup> is a heterocycloalkyl, or a cycloalkyl group;
- (2) -CONH- or -HNCO-; and
- (3) -CO-;
- (4) -SO<sub>2</sub>-R<sup>19</sup>- or -R<sup>19</sup>-SO<sub>2</sub>-;
- (5) -SO<sub>2</sub>-;
- (6) -NH-SO<sub>2</sub>- or -SO<sub>2</sub>-NH-; or

(7) E is absent and R is bonded directly to Y; and

Y is absent or is selected from the group consisting of a hydrido, alkyl, alkoxy, haloalkyl, aryl, aralkyl, cycloalkyl, heteroaryl, hydroxy, aryloxy, aralkoxy, heteroaryloxy, heteroaralkyl, perfluoroalkoxy, perfluoroalkylthio, trifluoromethylalkyl, alkenyl, heterocycloalkyl, cycloalkyl, trifluoromethyl, alkoxycarbonyl, and a aminoalkyl group, wherein the aryl or heteroaryl or heterocycloalkyl group is (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of an alkanoyl, halo, nitro, aralkyl, aryl, alkoxy, and an amino group wherein the amino nitrogen is (i) unsubstituted or (ii) substituted with one or two groups independently selected from hydrido, alkyl, and an aralkyl group.

74. The compound or salt according to claim 69 wherein said -G-A-R-E-Y substituent contains two to four carbocyclic or heterocyclic rings.

75. The compound or salt according to claim 69 wherein each of the two to four rings is 6-membered.

76. The compound or salt according to claim 69 wherein said -G-A-R-E-Y substituent has a length that is greater than a hexyl group and a length that is less than that of a stearyl group.

77. The compound or salt according to claim 69 wherein A is -O- or -S-.

78. The compound or salt according to claim 69 wherein R is an aryl, heteroaryl, cycloalkyl or heterocycloalkyl group.

79. The compound or salt according to claim 69 wherein E is absent.

10

80. The compound or salt according to claim 69 wherein Y is selected from the group consisting of hydrido, an alkyl, alkoxy, perfluoroalkoxy and a perfluoroalkylthio group.

15

81. The compound or salt according to claim 69 wherein R<sup>3</sup> is a radical that is comprised of a single-ringed aryl or heteroaryl group that is 5- or 6-membered, and is itself substituted at its own 4-position when a 6-membered ring and at its own 3- or 4-position when a 5-membered ring with a substituent selected from the group consisting of a thiophenoxy, 4-chlorophenoxy, 3-chlorophenoxy, 4-methoxyphenoxy, 3-benzodioxol-5-yloxy, 3,4-dimethylphenoxy, 4-fluorophenoxy, 4-fluorothiophenoxy, phenoxy, 4-trifluoromethoxyphenoxy, 4-trifluoromethylphenoxy, 4-(trifluoromethylthio)phenoxy, 4-(trifluoromethylthio)thiophenoxy, 4-chloro-3-fluorophenoxy, 4-isopropoxyphenoxy, 4-isopropylphenoxy, (2-methyl-1,3-benzothiazol-5-yl)oxy, 4-(1H-imidazol-1-yl)phenoxy, 4-chloro-3-

30

methylphenoxy, 3-methylphenoxy, 4-ethoxyphenoxy, 3,4-difluorophenoxy, 4-chloro-3-methylphenoxy, 4-fluoro-3-chlorophenoxy, 4-(1H-1,2,4-triazol-1-yl)phenoxy, 3,5-difluorophenoxy, 3,4-dichlorophenoxy, 4-cyclopentylphenoxy, 4-bromo-3-methylphenoxy, 4-bromophenoxy, 4-methylthiophenoxy, 4-phenylphenoxy, 4-benzylphenoxy, 6-quinolinylloxy, 4-amino-3-methylphenoxy, 3-methoxyphenoxy, 5,6,7,8-tetrahydro-2-naphthalenylloxy, 3-hydroxymethylphenoxy, N-piperidyl, N-piperazinyl and a 4-benzyloxyphenoxy group.

82. The compound or salt according to claim 69 wherein said  $R^3$  group is a  $PhR^{23}$  group, wherein Ph is a phenyl ring that is substituted at its 4-position by an  $R^{23}$  group that is a substituent selected from the group consisting of another single-ringed aryl or heteroaryl group, a piperidyl group, a piperazinyl group, a phenoxy group, a thiophenoxy group, a phenylazo group and a benzamido group.

83. The compound or salt according to claim 82 wherein said  $R^{23}$  group is itself substituted with a moiety that is selected from the group consisting of a halogen, a  $C_1$ - $C_4$  alkoxy group, a  $C_1$ - $C_4$  alkyl group, a dimethylamino group, a carboxyl  $C_1$ - $C_3$  alkylene group, a  $C_1$ - $C_4$  alkoxy carbonyl  $C_1$ - $C_3$  alkylene group, a trifluoromethylthio group, a trifluoromethoxy group, a trifluoromethyl group and a carboxamido  $C_1$ - $C_3$  alkylene group, or is substituted

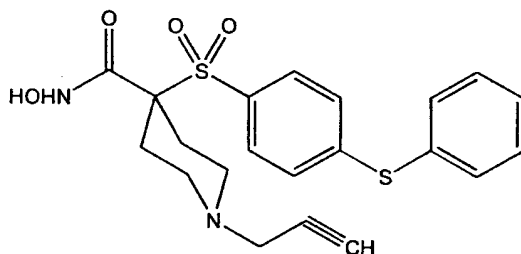
at the meta- and para-positions by a methylenedioxy group.

84. The compound or salt according to  
5 claim 83 wherein said  $R^{23}$  group is substituted at the para-position.

85. The compound or salt according to  
claim 84 wherein said  $R^{23}$  group is phenoxy.

10

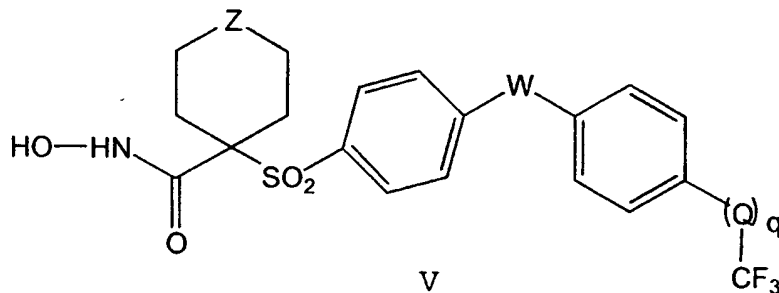
86. The compound or salt according to  
claim 69 wherein said inhibitor corresponds in  
structure to the formula



15

87. A compound corresponding in structure  
to formula V, below, or a pharmaceutically acceptable  
salt thereof

20



wherein

Z is O, S or NR<sup>6</sup>;

W and Q are independently oxygen (O), NR<sup>6</sup> or sulfur (S),

5 R<sup>6</sup> is selected from the group consisting of C<sub>3</sub>-C<sub>6</sub>-cycloalkyl, C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>6</sub>-alkenyl, C<sub>3</sub>-C<sub>6</sub>-alkynyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, amino-C<sub>1</sub>-C<sub>6</sub>-alkyl, aminosulfonyl, heteroaryl-C<sub>1</sub>-C<sub>6</sub>-alkyl, aryloxycarbonyl, and C<sub>1</sub>-C<sub>6</sub>-alkoxycarbonyl; and

10 q is zero or one such that when q is zero, Q is absent and the trifluoromethyl group is bonded directly to the depicted phenyl ring.

88. The compound or salt according to  
15 claim 87 wherein q is zero.

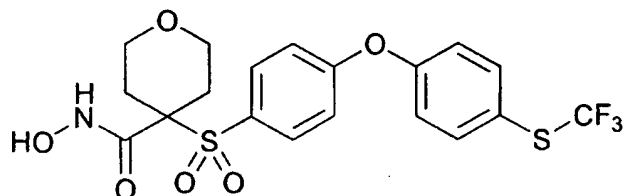
89. The compound or salt according to claim 87 wherein W is O.

20 90. The compound or salt according to claim 89 wherein q is zero.

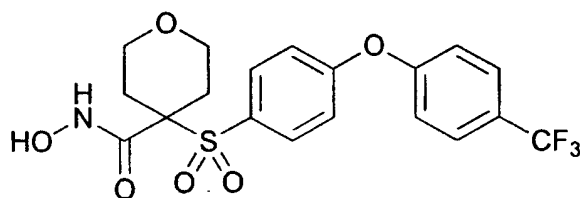
91. The compound or salt according to claim 89 wherein q is one and Q is O.

25 92. The compound or salt according to claim 89 wherein q is one and Q is S.

93. The compound or salt according to  
30 claim 87 wherein said inhibitor corresponds in structure to the formula

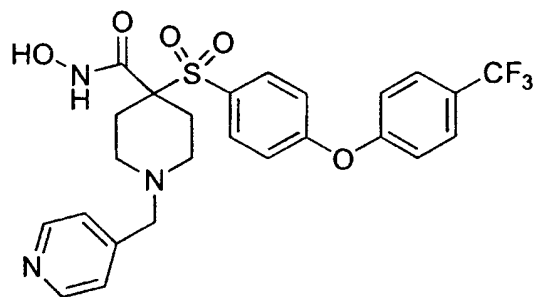


94. The compound or salt according to claim 87 wherein said inhibitor corresponds in structure to the formula



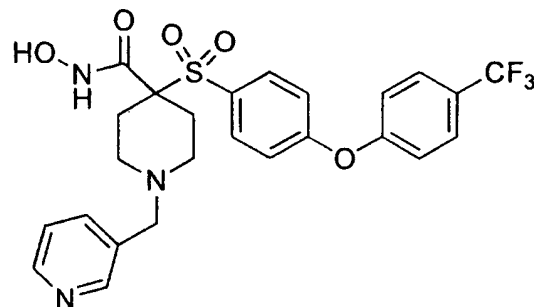
5

95. The compound or salt according to claim 87 wherein said inhibitor corresponds in structure to the formula

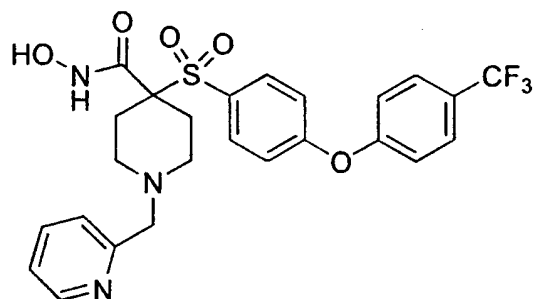


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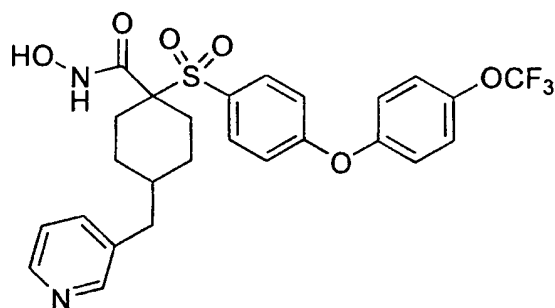
96. The compound or salt according to claim 87 wherein said inhibitor corresponds in structure to the formula



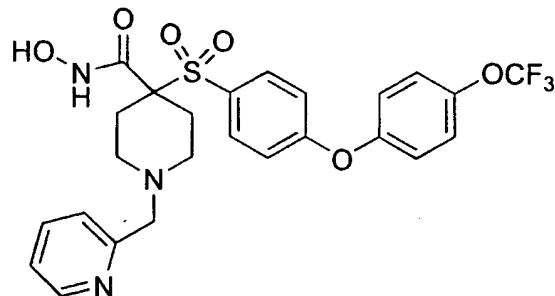
97. The compound or salt according to claim 87 wherein said inhibitor corresponds in structure to the formula



5 98. The compound or salt according to claim 87 wherein said inhibitor corresponds in structure to the formula

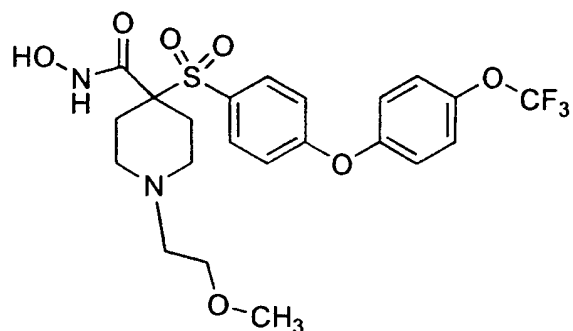


10 99. The compound or salt according to claim 87 wherein said inhibitor corresponds in structure to the formula



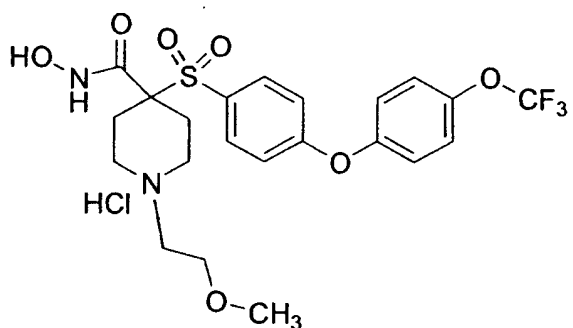
15 100. The compound or salt according to claim 87 wherein said inhibitor corresponds in structure to the formula





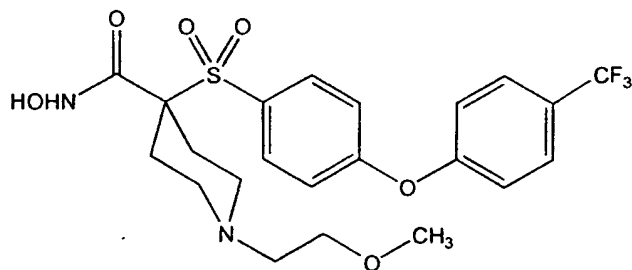
101. The compound or salt according to claim 100 wherein said inhibitor corresponds in structure to the formula

5

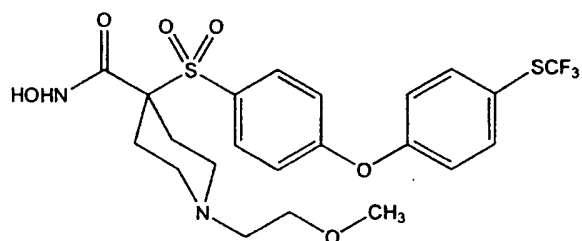


102. The compound or salt according to claim 87 wherein said inhibitor corresponds in structure to the formula

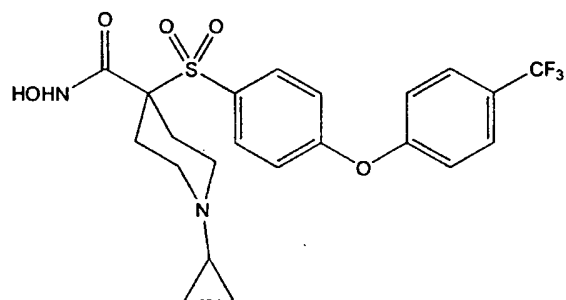
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103. The compound or salt according to claim 87 wherein said inhibitor corresponds in structure to the formula



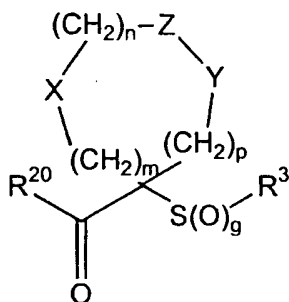
104. The compound or salt according to claim 87 wherein said inhibitor corresponds in structure to the formula



5

105. A compound corresponding in structure to formula VI, below

10



VI

wherein

g is zero, 1 or 2;

15

$R^3$  is an optionally substituted aryl or optionally substituted heteroaryl radical, and when

said aryl or heteroaryl radical is substituted, the substituent is (a) selected from the group consisting of an optionally substituted cycloalkyl, heterocycloalkyl, aryl, heteroaryl, aralkyl, heteroaralkyl, aralkoxy, heteroaralkoxy, aralkoxyalkyl, aryloxyalkyl, aralkanoylalkyl, arylcarbonylalkyl, aralkylaryl, aryloxyalkylaryl, aralkoxyaryl, arylazoaryl, arylhydrazinoaryl, alkylthioaryl, arylthioalkyl, alkylthioaralkyl, aralkylthioalkyl, an aralkylthioaryl radical, the sulfoxide or sulfone of any of the thio substituents, and a fused ring structure comprising two or more 5- or 6-membered rings selected from the group consisting of aryl, heteroaryl, cycloalkyl and heterocycloalkyl, and (b) is itself optionally substituted with one or more substituents independently selected from the group consisting of a cyano, perfluoroalkyl, trifluoromethoxy, trifluoromethylthio, haloalkyl, trifluoromethylalkyl, aralkoxycarbonyl, aryloxycarbonyl, hydroxy, halo, alkyl, alkoxy, nitro, thiol, hydroxycarbonyl, aryloxy, arylthio, aralkyl, aryl, arylcarbonylamino, heteroaryloxy, heteroarylthio, heteroaralkyl, cycloalkyl, heterocyclooxy, heterocyclothio, heterocycloamino, cycloalkyloxy, cycloalkylthio, heteroaralkoxy, heteroaralkylthio, aralkoxy, aralkylthio, aralkylamino, heterocyclo, heteroaryl, arylazo, hydroxycarbonylalkoxy, alkoxycarbonylalkoxy, alkanoyl, arylcarbonyl, aralkanoyl, alkanoyloxy, aralkanoyloxy, hydroxyalkyl, hydroxyalkoxy, alkylthio, alkoxyalkylthio, alkoxycarbonyl, aryloxyalkoxyaryl, arylthioalkylthioaryl, aryloxyalkylthioaryl, arylthioalkoxyaryl,

hydroxycarbonylalkoxy, hydroxycarbonylalkylthio,  
alkoxycarbonylalkoxy, alkoxycarbonylalkylthio, amino,  
wherein the amino nitrogen is (i) unsubstituted,  
or (ii) substituted with one or two substituents  
5 that are independently selected from the group  
consisting of an alkyl, aryl, heteroaryl,  
aralkyl, cycloalkyl, aralkoxycarbonyl,  
alkoxycarbonyl, arylcarbonyl, aralkanoyl,  
heteroarylcarbonyl, heteroaralkanoyl and an  
10 alkanoyl group, or (iii) wherein the amino  
nitrogen and two substituents attached thereto  
form a 5- to 8-membered heterocyclo or  
heteroaryl ring containing zero to two  
additional heteroatoms that are nitrogen, oxygen  
15 or sulfur and which ring itself is (a)  
unsubstituted or (b) substituted with one or two  
groups independently selected from the group  
consisting of an aryl, alkyl, heteroaryl,  
aralkyl, heteroaralkyl, hydroxy, alkoxy,  
20 alkanoyl, cycloalkyl, heterocycloalkyl,  
alkoxycarbonyl, hydroxyalkyl, trifluoromethyl,  
benzofused heterocycloalkyl, hydroxyalkoxyalkyl,  
aralkoxycarbonyl, hydroxycarbonyl,  
aryloxycarbonyl, benzofused heterocycloalkoxy,  
25 benzofused cycloalkylcarbonyl, heterocyclo-  
alkylcarbonyl, and a cycloalkylcarbonyl group,  
carbonylamino  
wherein the carbonylamino nitrogen is (i)  
unsubstituted, or (ii) is the reacted amine of  
30 an amino acid, or (iii) substituted with one or  
two radicals selected from the group consisting  
of an alkyl, hydroxyalkyl, hydroxyheteroaralkyl,  
cycloalkyl, aralkyl, trifluoromethylalkyl,

heterocycloalkyl, benzofused heterocycloalkyl, benzofused heterocycloalkyl, benzofused cycloalkyl, and an N,N-dialkylsubstituted alkylamino-alkyl group, or (iv) the carboxamido nitrogen and two substituents bonded thereto together form a 5- to 8-membered heterocyclo, heteroaryl or benzofused heterocycloalkyl ring that is itself unsubstituted or substituted with one or two radicals independently selected from the group consisting of an alkyl, alkoxycarbonyl, nitro, heterocycloalkyl, hydroxy, hydroxycarbonyl, aryl, aralkyl, heteroaralkyl and an amino group, wherein the amino nitrogen is (i) unsubstituted, or (ii) substituted with one or two substituents that are independently selected from the group consisting of alkyl, aryl, and heteroaryl, or (iii) wherein the amino nitrogen and two substituents attached thereto form a 5- to 8-membered heterocyclo or heteroaryl ring, and an aminoalkyl group wherein the aminoalkyl nitrogen is (i) unsubstituted, or (ii) substituted with one or two substituents independently selected from the group consisting of an alkyl, aryl, aralkyl, cycloalkyl, aralkoxycarbonyl, alkoxycarbonyl, and an alkanoyl group, or (iii) wherein the aminoalkyl nitrogen and two substituents attached thereto form a 5- to 8-membered heterocyclo or heteroaryl ring, or is an aryl or heteroaryl group that is substituted with a nucleophilically displaceable leaving group;

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m is zero, 1 or 2;

n is zero, 1 or 2;

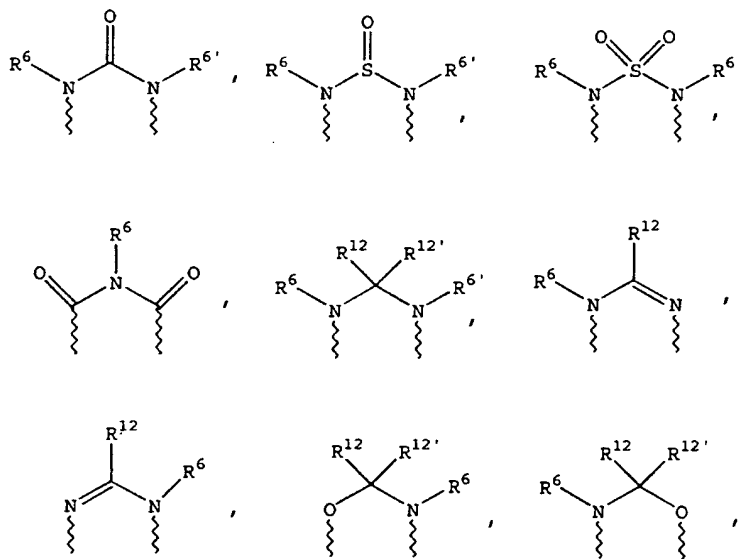
p is zero, 1 or 2;

the sum of  $m + n + p = 1, 2, 3$  or 4;

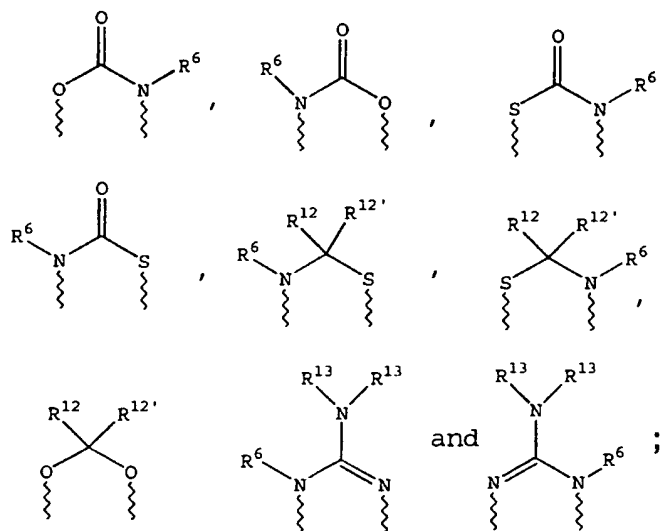
- 5 (a) one of X, Y and Z is selected from the group consisting of  $C(O)$ ,  $NR^6$ , O, S,  $S(O)$ ,  $S(O)_2$  and  $NS(O)_2R^7$ , and the remaining two of X, Y and Z are  $CR^8R^9$ , and  $CR^{10}R^{11}$ , or

- 10 (b) X and Z or Z and Y together constitute a moiety that is selected from the group consisting of  $NR^6C(O)$ ,  $NR^6S(O)$ ,  $NR^6S(O)_2$ ,  $NR^6S$ ,  $NR^6O$ ,  $SS$ ,  $NR^6NR^6$  and  $OC(O)$ , with the remaining one of X, Y and Z being  $CR^8R^9$ , or

- 15 (c) n is zero and X, Y and Z together constitute a moiety selected from the group consisting of



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wherein wavy lines are bonds to the atoms of the depicted ring;

- 5                R<sup>6</sup> and R<sup>6</sup>' are independently selected from the group consisting of hydrido, C<sub>1</sub>-C<sub>6</sub>-alkanoyl, C<sub>6</sub>-aryl-C<sub>1</sub>-C<sub>6</sub>-alkyl, aroyl, bis(C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl)-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-haloalkyl, C<sub>1</sub>-C<sub>6</sub>-perfluoroalkyl, C<sub>1</sub>-C<sub>6</sub>-trifluoromethylalkyl, C<sub>1</sub>-C<sub>6</sub>-perfluoroalkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>6</sub>-cycloalkyl, C<sub>3</sub>-C<sub>8</sub>-heterocycloalkyl, C<sub>3</sub>-C<sub>8</sub>-heterocycloalkylcarbonyl, C<sub>6</sub>-aryl, C<sub>5</sub>-C<sub>6</sub>-heterocyclo, C<sub>5</sub>-C<sub>6</sub>-heteroaryl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>6</sub>-aryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryl-C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroarylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>6</sub>-arylsulfonyl, C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl, C<sub>5</sub>-C<sub>6</sub>-heteroarylsulfonyl, carboxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>4</sub>-alkoxycarbonyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, aminocarbonyl, C<sub>1</sub>-C<sub>6</sub>-alkyliminocarbonyl, C<sub>6</sub>-

aryliminocarbonyl, C<sub>5</sub>-C<sub>6</sub>-heterocycloiminocarbonyl,  
C<sub>6</sub>-arylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl,  
C<sub>6</sub>-arylthio-C<sub>3</sub>-C<sub>6</sub>-alkenyl, C<sub>1</sub>-C<sub>4</sub>-alkylthio-C<sub>3</sub>-C<sub>6</sub>-  
alkenyl, C<sub>5</sub>-C<sub>6</sub>-heteroaryl-C<sub>1</sub>-C<sub>6</sub>-alkyl, halo-C<sub>1</sub>-C<sub>6</sub>-  
5 alkanoyl, hydroxy-C<sub>1</sub>-C<sub>6</sub>-alkanoyl, thiol-C<sub>1</sub>-C<sub>6</sub>-  
alkanoyl, C<sub>3</sub>-C<sub>6</sub>-alkenyl, C<sub>3</sub>-C<sub>6</sub>-alkynyl, C<sub>1</sub>-C<sub>4</sub>-alkoxy-  
C<sub>1</sub>-C<sub>4</sub>-alkyl, C<sub>1</sub>-C<sub>5</sub>-alkoxycarbonyl, aryloxycarbonyl,  
NR<sup>8</sup>R<sup>9</sup>-C<sub>1</sub>-C<sub>5</sub>-alkylcarbonyl, hydroxy-C<sub>1</sub>-C<sub>5</sub>-alkyl, an  
aminocarbonyl wherein the aminocarbonyl nitrogen is  
10 (i) unsubstituted or (ii) substituted with one or two  
radicals independently selected from the group  
consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-  
cycloalkyl and a C<sub>1</sub>-C<sub>6</sub>-alkanoyl group,  
hydroxyaminocarbonyl, an aminosulfonyl group wherein  
15 the aminosulfonyl nitrogen is (i) unsubstituted or  
(ii) substituted with one or two radicals  
independently selected from the group consisting of  
C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl and a  
C<sub>1</sub>-C<sub>6</sub>-alkanoyl group, an amino-C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl  
20 group wherein the amino-C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl nitrogen  
is (i) unsubstituted or (ii) substituted with one or  
two radicals independently selected from the group  
consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-  
cycloalkyl and a C<sub>1</sub>-C<sub>6</sub>-alkanoyl group and an amino-  
25 C<sub>1</sub>-C<sub>6</sub>-alkyl group wherein the aminoalkyl nitrogen is  
(i) unsubstituted or (ii) substituted with one or two  
radicals independently selected from the group  
consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-  
cycloalkyl and a C<sub>1</sub>-C<sub>6</sub>-alkanoyl group;



$R^7$  is selected from the group consisting of a arylalkyl, aryl, heteroaryl, heterocyclo,  $C_1$ - $C_6$ -alkyl,  $C_3$ - $C_6$ -alkynyl,  $C_3$ - $C_6$ -alkenyl,  $C_1$ - $C_6$ -carboxyalkyl and a  $C_1$ - $C_6$ -hydroxyalkyl group;

- 5  $R^8$  and  $R^9$  and  $R^{10}$  and  $R^{11}$  are independently selected from the group consisting of a hydrido, hydroxy,  $C_1$ - $C_6$ -alkyl, aryl, ar- $C_1$ - $C_6$ -alkyl, heteroaryl, heteroar- $C_1$ - $C_6$ -alkyl,  $C_2$ - $C_6$ -alkynyl,  $C_2$ - $C_6$ -alkenyl, thiol- $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_6$ -alkylthio- $C_1$ - $C_6$ -alkyl cycloalkyl, cycloalkyl- $C_1$ - $C_6$ -alkyl, heterocycloalkyl- $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_6$ -alkoxy- $C_1$ - $C_6$ -alkyl, aralkoxy- $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_6$ -alkoxy- $C_1$ - $C_6$ -alkoxy- $C_1$ - $C_6$ -alkyl, hydroxy- $C_1$ - $C_6$ -alkyl, hydroxycarbonyl- $C_1$ - $C_6$ -alkyl, hydroxycarbonylar- $C_1$ - $C_6$ -alkyl, aminocarbonyl- $C_1$ - $C_6$ -alkyl, aryloxy- $C_1$ - $C_6$ -alkyl, heteroaryloxy- $C_1$ - $C_6$ -alkyl, arylthio- $C_1$ - $C_6$ -alkyl, heteroarylthio- $C_1$ - $C_6$ -alkyl, the sulfoxide or sulfone of any said thio substituents, perfluoro- $C_1$ - $C_6$ -alkyl, trifluoromethyl- $C_1$ - $C_6$ -alkyl, halo- $C_1$ - $C_6$ -alkyl, alkoxy-carbonylamino- $C_1$ - $C_6$ -alkyl and an amino- $C_1$ - $C_6$ -alkyl group wherein the aminoalkyl nitrogen is (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of  $C_1$ - $C_6$ -alkyl, ar- $C_1$ - $C_6$ -alkyl, cycloalkyl and  $C_1$ - $C_6$ -alkanoyl, or wherein  $R^8$  and  $R^9$  or  $R^{10}$  and  $R^{11}$  and the carbon to which they are bonded form a carbonyl group, or wherein  $R^8$  and  $R^9$  or  $R^{10}$  and  $R^{11}$ , or  $R^8$  and  $R^{10}$  together with the atoms to which they

are bonded form a 5- to 8-membered carbocyclic ring,  
or a 5- to 8-membered heterocyclic ring containing  
one or two heteroatoms that are nitrogen, oxygen, or  
sulfur, with the proviso that only one of R<sup>8</sup> and R<sup>9</sup>  
5 or R<sup>10</sup> and R<sup>11</sup> is hydroxy;

R<sup>12</sup> and R<sup>12'</sup> are independently selected  
from the group consisting of a hydrido, C<sub>1</sub>-C<sub>6</sub>-alkyl,  
aryl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryl, heteroaralkyl, C<sub>2</sub>-  
C<sub>6</sub>-alkynyl, C<sub>2</sub>-C<sub>6</sub>-alkenyl, thiol-C<sub>1</sub>-C<sub>6</sub>-alkyl,  
10 cycloalkyl, cycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, heterocycloalkyl-  
C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, aryloxy-C<sub>1</sub>-C<sub>6</sub>-  
alkyl, amino-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkoxy-  
C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxycarbonyl-C<sub>1</sub>-  
C<sub>6</sub>-alkyl, hydroxycarbonylar-C<sub>1</sub>-C<sub>6</sub>-alkyl,  
15 aminocarbonyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, aryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl,  
heteroaryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkylthio-C<sub>1</sub>-C<sub>6</sub>-  
alkyl, arylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroarylthio-C<sub>1</sub>-C<sub>6</sub>-  
alkyl, the sulfoxide or sulfone of any said thio  
substituents, perfluoro-C<sub>1</sub>-C<sub>6</sub>-alkyl, trifluoromethyl-  
20 C<sub>1</sub>-C<sub>6</sub>-alkyl, halo-C<sub>1</sub>-C<sub>6</sub>-alkyl, alkoxycarbonylamino-  
C<sub>1</sub>-C<sub>6</sub>-alkyl and an amino-C<sub>1</sub>-C<sub>6</sub>-alkyl group wherein  
the aminoalkyl nitrogen is (i) unsubstituted or (ii)  
substituted with one or two radicals independently  
selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl,  
25 ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, cycloalkyl and C<sub>1</sub>-C<sub>6</sub>-alkanoyl;

R<sup>13</sup> is selected from the group consisting  
of a hydrido, benzyl, phenyl, C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>2</sub>-C<sub>6</sub>-

alkynyl, C<sub>2</sub>-C<sub>6</sub>-alkenyl and a C<sub>1</sub>-C<sub>6</sub>-hydroxyalkyl group; and

- R<sup>20</sup> is (a) -O-R<sup>21</sup>, wherein R<sup>21</sup> is selected from the group consisting of a hydrido, C<sub>1</sub>-C<sub>6</sub>-alkyl, aryl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl group and a pharmaceutically acceptable cation, (b) -NH-O-R<sup>22</sup>, wherein R<sup>22</sup> is a selectively removable protecting group such as a 2-tetrahydropyranyl, benzyl, p-methoxybenzyl, carbonyl-C<sub>1</sub>-C<sub>6</sub>-alkoxy, trisubstituted silyl group, an o-nitrophenyl group, and a peptide synthesis resin, wherein the trisubstituted silyl group is substituted with C<sub>1</sub>-C<sub>6</sub>-alkyl, aryl, or ar-C<sub>1</sub>-C<sub>6</sub>-alkyl or a mixture thereof, (c) -NH-O-R<sup>14</sup>, where R<sup>14</sup> is hydrido, a pharmaceutically acceptable cation or C(W)R<sup>25</sup> where W is O or S and R<sup>25</sup> is selected from the group consisting of an C<sub>1</sub>-C<sub>6</sub>-alkyl, aryl, C<sub>1</sub>-C<sub>6</sub>-alkoxy, heteroaryl-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, aryloxy, ar-C<sub>1</sub>-C<sub>6</sub>-alkoxy, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryl and amino C<sub>1</sub>-C<sub>6</sub>-alkyl group wherein the amino C<sub>1</sub>-C<sub>6</sub>-alkyl nitrogen is (i) unsubstituted or (ii) substituted with one or two substituents independently selected from the group consisting of an C<sub>1</sub>-C<sub>6</sub>-alkyl, aryl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkoxycarbonyl, C<sub>1</sub>-C<sub>6</sub>-alkoxycarbonyl, and C<sub>1</sub>-C<sub>6</sub>-alkanoyl radical, or (iii) wherein the amino C<sub>1</sub>-C<sub>6</sub>-alkyl nitrogen and two substituents attached thereto form a 5- to 8-membered heterocyclo or heteroaryl ring, or (d) -NR<sup>26</sup>R<sup>27</sup>, where R<sup>26</sup> and R<sup>27</sup> are independently selected from the

group consisting of a hydrido, C<sub>1</sub>-C<sub>6</sub>-alkyl, amino C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxy C<sub>1</sub>-C<sub>6</sub>-alkyl, aryl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl group, or R<sup>26</sup> and R<sup>27</sup> together with the depicted nitrogen atom form a 5- to 8-membered ring  
5 containing zero or one additional heteroatom that is oxygen, nitrogen or sulfur.

106. The compound according to claim 105 wherein R<sup>3</sup> is the substituent G-A-R-E-Y wherein
- 10 G is an aryl or heteroaryl group;  
A is selected from the group consisting of
- (1) -O-;
  - (2) -S-;
  - (3) -NR<sup>17</sup>-;
  - 15 (4) -CO-N(R<sup>17</sup>) or -N(R<sup>17</sup>)-CO-, wherein R<sup>17</sup> is hydrogen, C<sub>1</sub>-C<sub>4</sub>-alkyl, or phenyl;
  - (5) -CO-O- or -O-CO-;
  - (6) -O-CO-O-;
  - (7) -HC=CH-;
  - 20 (8) -NH-CO-NH-;
  - (9) -C≡C-;
  - (10) -NH-CO-O- or -O-CO-NH-;
  - (11) -N=N-;
  - (12) -NH-NH-; and
  - 25 (13) -CS-N(R<sup>18</sup>)- or -N(R<sup>18</sup>)-CS-, wherein R<sup>18</sup> is hydrogen C<sub>1</sub>-C<sub>4</sub>-alkyl, or phenyl; or
  - (14) A is absent and G is bonded directly to R;

R is a moiety selected from the group consisting of alkyl, alkoxyalkyl, aryl, heteroaryl, cycloalkyl, heterocycloalkyl, aralkyl, heteroaralkyl, heterocycloalkylalkyl, cycloalkylalkyl, 5 cycloalkoxyalkyl, heterocycloalkoxyalkyl, aryloxyalkyl, heteroaryloxyalkyl, arylthioalkyl, heteroarylthioalkyl, cycloalkylthioalkyl, and a heterocycloalkylthioalkyl group wherein the aryl or heteroaryl or cycloalkyl or heterocycloalkyl 10 substituent is (i) unsubstituted or (ii) substituted with one or two radicals selected from the group consisting of a halo, alkyl, perfluoroalkyl, perfluoroalkoxy, perfluoroalkylthio, trifluoromethylalkyl, amino, alkoxycarbonylalkyl, 15 alkoxy, C<sub>1</sub>-C<sub>2</sub>-alkylene-dioxy, hydroxycarbonylalkyl, hydroxycarbonylalkylamino, nitro, hydroxy, hydroxyalkyl, alkanoylamino, and a alkoxycarbonyl group, and R is other than alkyl or alkoxyalkyl when A is -O- or -S-;

20 E is selected from the group consisting of

- (1) -CO(R<sup>19</sup>)- or -(R<sup>19</sup>)CO-, wherein R<sup>19</sup> is a heterocycloalkyl, or a cycloalkyl group;
- (2) -CONH- or -HNCO-; and
- 25 (3) -CO-;
- (4) -SO<sub>2</sub>-R<sup>19</sup>- or -R<sup>19</sup>-SO<sub>2</sub>-;
- (5) -SO<sub>2</sub>-;
- (6) -NH-SO<sub>2</sub>- or -SO<sub>2</sub>-NH-; or
- (7) E is absent and R is bonded directly 30 to Y; and

Y is absent or is selected from the group consisting of a hydrido, alkyl, alkoxy, haloalkyl, aryl, aralkyl, cycloalkyl, heteroaryl, hydroxy, aryloxy, aralkoxy, heteroaryloxy, heteroaralkyl, 5 perfluoroalkoxy, perfluoroalkylthio, trifluoromethylalkyl, alkenyl, heterocycloalkyl, cycloalkyl, trifluoromethyl, alkoxycarbonyl, and a aminoalkyl group, wherein the aryl or heteroaryl or heterocycloalkyl group is (i) unsubstituted or (ii) 10 substituted with one or two radicals independently selected from the group consisting of an alkanoyl, halo, nitro, aralkyl, aryl, alkoxy, and an amino group wherein the amino nitrogen is (i) unsubstituted or (ii) substituted with one or two groups 15 independently selected from hydrido, alkyl, and an aralkyl group.

107. The compound according to claim 106 wherein said -G-A-R-E-Y substituent contains two to 20 four carbocyclic or heterocyclic rings.

108. The compound according to claim 107 wherein each of the two to four rings is 6-membered.

25 109. The compound according to claim 106 wherein said -G-A-R-E-Y substituent has a length that is greater than a hexyl group and a length that is less than that of a stearyl group.

30 110. The compound according to claim 106 wherein A is -O- or -S-.

111. The compound according to claim 106 wherein R is an aryl, heteroaryl, cycloalkyl or heterocycloalkyl group.

5 112. The compound according to claim 106 wherein E is absent.

113. The compound according to claim 106 wherein Y is selected from the group consisting of  
10 hydrido, an alkyl, alkoxy, perfluoroalkoxy and a perfluoroalkylthio group.

114. The compound according to claim 105 wherein R<sup>14</sup> is hydrido.

15

115. The compound according to claim 105 wherein W of the C(W)R<sup>25</sup> is O and R<sup>25</sup> is a C<sub>1</sub>-C<sub>6</sub>-alkyl, aryl, C<sub>1</sub>-C<sub>6</sub>-alkoxy, heteroaryl-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, or aryloxy group.

20

116. The compound according to claim 105 wherein R<sup>3</sup> is a single-ringed aryl or heteroaryl group that is 5- or 6-membered, and is itself substituted at its own 4-position when a 6-membered  
25 ring and at its own 3- or 4-position when a 5-membered ring with a substituent selected from the group consisting of a thiophenoxy, 4-chloro-phenoxy, 3-chlorophenoxy, 4-methoxyphenoxy, 3-benzodioxol-5-yloxy, 3,4-dimethylphenoxy, 4-fluorophenoxy, 4-  
30 fluorothiophenoxy, phenoxy, 4-trifluoro-methoxyphenoxy, 4-trifluoromethylphenoxy, 4-

(trifluoromethylthio)phenoxy, 4-(trifluoromethylthio)thiophenoxy, 4-chloro-3-fluorophenoxy, 4-isopropoxyphenoxy, 4-isopropylphenoxy, (2-methyl-1,3-benzothiazol-5-yl)oxy, 4-(1H-imidazol-1-yl)phenoxy,  
5 4-chloro-3-methylphenoxy, 3-methyl-phenoxy, 4-ethoxyphenoxy, 3,4-difluorophenoxy, 4-chloro-3-methylphenoxy, 4-fluoro-3-chlorophenoxy, 4-(1H-1,2,4-triazol-1-yl)phenoxy, 3,5-difluorophenoxy, 3,4-dichlorophenoxy, 4-cyclopentylphenoxy, 4-bromo-3-methylphenoxy, 4-bromophenoxy, 4-methylthiophenoxy,  
10 4-phenylphenoxy, 4-benzylphenoxy, 6-quinolinyl, 4-amino-3-methylphenoxy, 3-methoxyphenoxy, 5,6,7,8-tetrahydro-2-naphthalenyloxy, 3-hydroxymethylphenoxy, and a 4-benzyloxyphenoxy group.

15

117. The compound according to claim 105 wherein said selectively removable protecting group is selected from the group consisting of a 2-tetrahydropyranyl, benzyl, p-methoxybenzyloxy-  
20 carbonyl, benzyloxycarbonyl, C<sub>1</sub>-C<sub>6</sub>-alkoxycarbonyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-CH<sub>2</sub>- , C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkoxy-CH<sub>2</sub>- and an o-nitrophenyl group.

118. The compound according to claim 105  
25 wherein said nucleophilically displaceable leaving group is selected from the group consisting of a halo, nitro, azido, phenylsulfoxido, aryloxy, C<sub>1</sub>-C<sub>6</sub>-alkoxy, a C<sub>1</sub>-C<sub>6</sub>-alkylsulfonate or arylsulfonate group and a trisubstituted ammonium group in which the  
30 three substituents are independently aryl, ar- C<sub>1</sub>-C<sub>6</sub>-alkyl or C<sub>1</sub>-C<sub>6</sub>-alkyl.



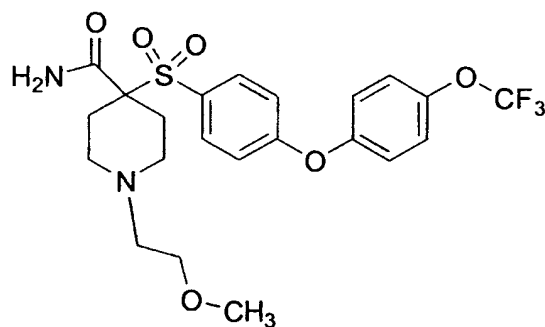
119. The compound according to claim 105 wherein g is zero.

5 120. The compound according to claim 105 wherein  $R^{20}$  is  $-NR^{26}R^{27}$ .

121. The compound according to claim 120 wherein  $R^{26}$  and  $R^{27}$  are both hydrido.

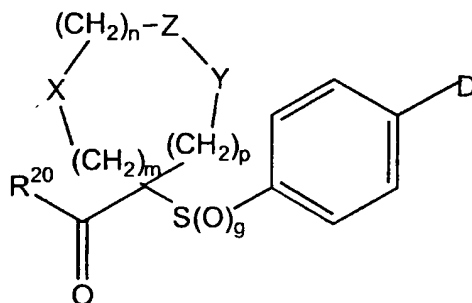
10

122. A compound that corresponds in structure to the formula below, or a pharmaceutically acceptable salt thereof



15

123. An intermediate compound that corresponds in structure to formula VII, below



VII

20

wherein

g is zero, 1 or 2;

D is a nucleophilically displaceable

5 leaving group;

m is zero, 1 or 2;

n is zero, 1 or 2;

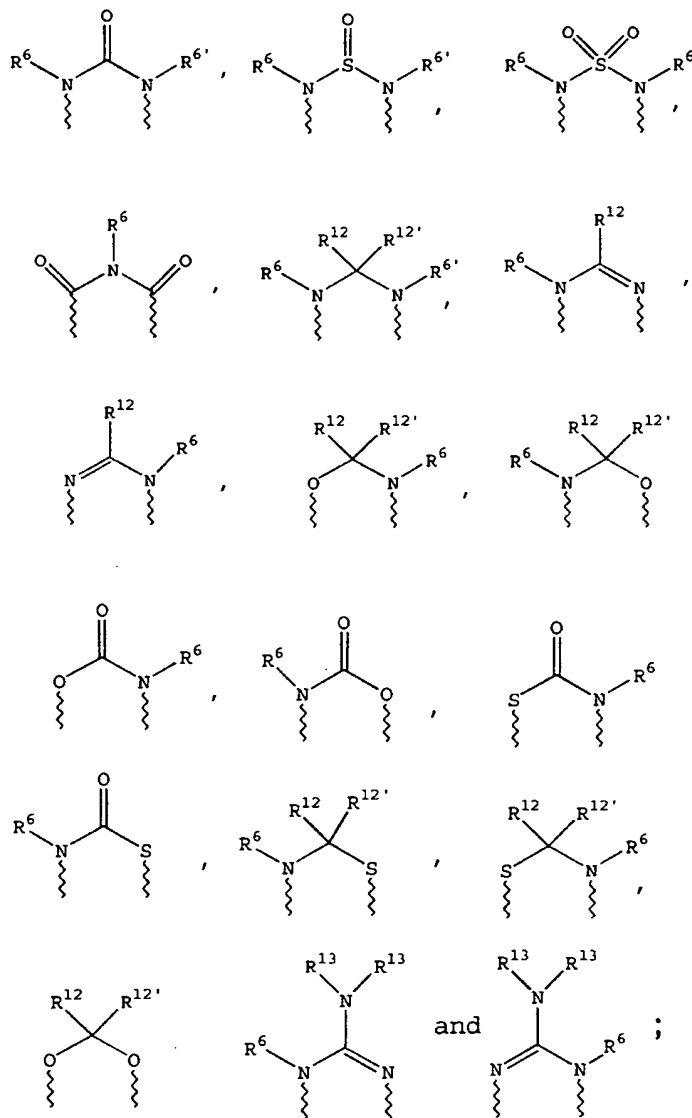
p is zero, 1 or 2;

the sum of  $m + n + p = 1, 2, 3$  or 4;

10 (a) one of X, Y and Z is selected from the group consisting of  $C(O)$ ,  $NR^6$ , O, S,  $S(O)$ ,  $S(O)_2$  and  $NS(O)_2R^7$ , and the remaining two of X, Y and Z are  $CR^8R^9$ , and  $CR^{10}R^{11}$ , or

(b) X and Z or Z and Y together  
15 constitute a moiety that is selected from the group consisting of  $NR^6C(O)$ ,  $NR^6S(O)$ ,  $NR^6S(O)_2$ ,  $NR^6S$ ,  $NR^6O$ , SS,  $NR^6NR^6$  and  $OC(O)$ , with the remaining one of X, Y and Z being  $CR^8R^9$ , or

(c) n is zero and X, Y and Z together  
20 constitute a moiety selected from the group consisting of



5                    wherein wavy lines are bonds to the atoms  
of the depicted ring;

$R^6$  and  $R^{6'}$  are independently selected from  
the group consisting of hydrido,  $C_1$ - $C_6$ -alkanoyl,  $C_6$ -  
aryl- $C_1$ - $C_6$ -alkyl, aroyl, bis( $C_1$ - $C_6$ -alkoxy- $C_1$ - $C_6$ -  
10 alkyl)- $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_6$ -haloalkyl,  $C_1$ -  
 $C_6$ -perfluoroalkyl,  $C_1$ - $C_6$ -trifluoromethylalkyl,  $C_1$ - $C_6$ -

- perfluoroalkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>6</sub>-cycloalkyl, C<sub>3</sub>-C<sub>8</sub>-heterocycloalkyl, C<sub>3</sub>-C<sub>8</sub>-heterocycloalkylcarbonyl, C<sub>6</sub>-aryl, C<sub>5</sub>-C<sub>6</sub>-heterocyclo, C<sub>5</sub>-C<sub>6</sub>-heteroaryl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>6</sub>-aryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryl-C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroarylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>6</sub>-arylsulfonyl, C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl, C<sub>5</sub>-C<sub>6</sub>-heteroarylsulfonyl, carboxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>4</sub>-alkoxycarbonyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, aminocarbonyl, C<sub>1</sub>-C<sub>6</sub>-alkyliminocarbonyl, C<sub>6</sub>-aryliminocarbonyl, C<sub>5</sub>-C<sub>6</sub>-heterocycloiminocarbonyl, C<sub>6</sub>-arylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>6</sub>-arylthio-C<sub>3</sub>-C<sub>6</sub>-alkenyl, C<sub>1</sub>-C<sub>4</sub>-alkylthio-C<sub>3</sub>-C<sub>6</sub>-alkenyl, C<sub>5</sub>-C<sub>6</sub>-heteroaryl-C<sub>1</sub>-C<sub>6</sub>-alkyl, halo-C<sub>1</sub>-C<sub>6</sub>-alkanoyl, hydroxy-C<sub>1</sub>-C<sub>6</sub>-alkanoyl, thiol-C<sub>1</sub>-C<sub>6</sub>-alkanoyl, C<sub>3</sub>-C<sub>6</sub>-alkenyl, C<sub>3</sub>-C<sub>6</sub>-alkynyl, C<sub>1</sub>-C<sub>4</sub>-alkoxy-C<sub>1</sub>-C<sub>4</sub>-alkyl, C<sub>1</sub>-C<sub>5</sub>-alkoxycarbonyl, aryloxycarbonyl, NR<sup>8</sup>R<sup>9</sup>-C<sub>1</sub>-C<sub>5</sub>-alkylcarbonyl, hydroxy-C<sub>1</sub>-C<sub>5</sub>-alkyl, an aminocarbonyl wherein the aminocarbonyl nitrogen is (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl and a C<sub>1</sub>-C<sub>6</sub>-alkanoyl group, hydroxyaminocarbonyl, an aminosulfonyl group wherein the aminosulfonyl nitrogen is (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl and a

C<sub>1</sub>-C<sub>6</sub>-alkanoyl group, an amino-C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl group wherein the amino-C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl nitrogen is (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl and a C<sub>1</sub>-C<sub>6</sub>-alkanoyl group and an amino-C<sub>1</sub>-C<sub>6</sub>-alkyl group wherein the aminoalkyl nitrogen is (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl and a C<sub>1</sub>-C<sub>6</sub>-alkanoyl group;

R<sup>7</sup> is selected from the group consisting of a arylalkyl, aryl, heteroaryl, heterocyclo, C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>6</sub>-alkynyl, C<sub>3</sub>-C<sub>6</sub>-alkenyl, C<sub>1</sub>-C<sub>6</sub>-carboxyalkyl and a C<sub>1</sub>-C<sub>6</sub>-hydroxyalkyl group;

R<sup>8</sup> and R<sup>9</sup> and R<sup>10</sup> and R<sup>11</sup> are independently selected from the group consisting of a hydrido, hydroxy, C<sub>1</sub>-C<sub>6</sub>-alkyl, aryl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryl, heteroar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>2</sub>-C<sub>6</sub>-alkynyl, C<sub>2</sub>-C<sub>6</sub>-alkenyl, thiol-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl cycloalkyl, cycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, heterocycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, aralkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxycarbonyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxycarbonylar-C<sub>1</sub>-C<sub>6</sub>-alkyl, aminocarbonyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, aryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, arylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroarylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, the sulfoxide or

sulfone of any said thio substituents, perfluoro-C<sub>1</sub>-C<sub>6</sub>-alkyl, trifluoromethyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, halo-C<sub>1</sub>-C<sub>6</sub>-alkyl, alkoxycarbonylamino-C<sub>1</sub>-C<sub>6</sub>-alkyl and an amino-C<sub>1</sub>-C<sub>6</sub>-alkyl group wherein the aminoalkyl nitrogen is

5 (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, cycloalkyl and C<sub>1</sub>-C<sub>6</sub>-alkanoyl, or wherein R<sup>8</sup> and R<sup>9</sup> or R<sup>10</sup> and R<sup>11</sup> and the carbon to which they are bonded form a

10 carbonyl group, or wherein R<sup>8</sup> and R<sup>9</sup> or R<sup>10</sup> and R<sup>11</sup>, or R<sup>8</sup> and R<sup>10</sup> together with the atoms to which they are bonded form a 5- to 8-membered carbocyclic ring, or a 5- to 8-membered heterocyclic ring containing one or two heteroatoms that are nitrogen, oxygen, or

15 sulfur, with the proviso that only one of R<sup>8</sup> and R<sup>9</sup> or R<sup>10</sup> and R<sup>11</sup> is hydroxy;

R<sup>12</sup> and R<sup>12'</sup> are independently selected from the group consisting of a hydrido, C<sub>1</sub>-C<sub>6</sub>-alkyl, aryl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryl, heteroaralkyl, C<sub>2</sub>-C<sub>6</sub>-alkynyl, C<sub>2</sub>-C<sub>6</sub>-alkenyl, thiol-C<sub>1</sub>-C<sub>6</sub>-alkyl,

20 cycloalkyl, cycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, heterocycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, aryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, amino-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxycarbonyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxycarbonylar-C<sub>1</sub>-C<sub>6</sub>-alkyl,

25 aminocarbonyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, aryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, arylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroarylthio-C<sub>1</sub>-C<sub>6</sub>-

alkyl, the sulfoxide or sulfone of any said thio substituents, perfluoro-C<sub>1</sub>-C<sub>6</sub>-alkyl, trifluoromethyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, halo-C<sub>1</sub>-C<sub>6</sub>-alkyl, alkoxycarbonylamino-C<sub>1</sub>-C<sub>6</sub>-alkyl and an amino-C<sub>1</sub>-C<sub>6</sub>-alkyl group wherein  
5 the aminoalkyl nitrogen is (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, cycloalkyl and C<sub>1</sub>-C<sub>6</sub>-alkanoyl;

R<sup>13</sup> is selected from the group consisting  
10 of a hydrido, benzyl, phenyl, C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>2</sub>-C<sub>6</sub>-alkynyl, C<sub>2</sub>-C<sub>6</sub>-alkenyl and a C<sub>1</sub>-C<sub>6</sub>-hydroxyalkyl group; and

R<sup>20</sup> is (a) -O-R<sup>21</sup>, wherein R<sup>21</sup> is selected from the group consisting of a hydrido, C<sub>1</sub>-C<sub>6</sub>-alkyl, aryl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl group and a pharmaceutically  
15 acceptable cation, (b) -NH-O-R<sup>22</sup>, wherein R<sup>22</sup> is a selectively removable protecting group such as a 2-tetrahydropyranyl, benzyl, p-methoxybenzyl, carbonyl-C<sub>1</sub>-C<sub>6</sub>-alkoxy, trisubstituted silyl group, an  
20 o-nitrophenyl group, and a peptide synthesis resin, wherein the trisubstituted silyl group is substituted with C<sub>1</sub>-C<sub>6</sub>-alkyl, aryl, or ar-C<sub>1</sub>-C<sub>6</sub>-alkyl or a mixture thereof, (c) -NH-O-R<sup>14</sup>, where R<sup>14</sup> is hydrido, a pharmaceutically acceptable cation or C(W)R<sup>25</sup> where  
25 W is O or S and R<sup>25</sup> is selected from the group consisting of an C<sub>1</sub>-C<sub>6</sub>-alkyl, aryl, C<sub>1</sub>-C<sub>6</sub>-alkoxy, heteroaryl-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, aryloxy, ar-C<sub>1</sub>-C<sub>6</sub>-alkoxy, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryl and amino C<sub>1</sub>-C<sub>6</sub>-alkyl group wherein the amino C<sub>1</sub>-C<sub>6</sub>-

alkyl nitrogen is (i) unsubstituted or (ii) substituted with one or two substituents independently selected from the group consisting of an C<sub>1</sub>-C<sub>6</sub>-alkyl, aryl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-  
5 cycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkoxycarbonyl, C<sub>1</sub>-C<sub>6</sub>-alkoxycarbonyl, and C<sub>1</sub>-C<sub>6</sub>-alkanoyl radical, or (iii) wherein the amino C<sub>1</sub>-C<sub>6</sub>-alkyl nitrogen and two substituents attached thereto form a 5- to 8-membered heterocyclo or heteroaryl ring, or (d) -NR<sup>26</sup>R<sup>27</sup>,  
10 where R<sup>26</sup> and R<sup>27</sup> are independently selected from the group consisting of a hydrido, C<sub>1</sub>-C<sub>6</sub>-alkyl, amino C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxy C<sub>1</sub>-C<sub>6</sub>-alkyl, aryl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl group, or R<sup>26</sup> and R<sup>27</sup> together with the depicted nitrogen atom form a 5- to 8-membered ring containing  
15 zero or one additional heteroatom that is oxygen, nitrogen or sulfur.

124. The compound according to claim 123 wherein said selectively removable protecting group  
20 is selected from the group consisting of a 2-tetrahydropyranyl, C<sub>1</sub>-C<sub>6</sub>-acyl, aroyl, benzyl, p-methoxybenzyloxycarbonyl, benzyloxycarbonyl, C<sub>1</sub>-C<sub>6</sub>-alkoxycarbonyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-CH<sub>2</sub>-, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkoxy-CH<sub>2</sub>- and an o-nitrophenyl group.

25

125. The compound according to claim 123 wherein said nucleophilically displaceable leaving group, D, is selected from the group consisting of a halo, nitro, azido, phenylsulfoxido, aryloxy, C<sub>1</sub>-C<sub>6</sub>-  
30 alkoxy, a C<sub>1</sub>-C<sub>6</sub>-alkylsulfonate or arylsulfonate group



and a trisubstituted ammonium group in which the three substituents are independently aryl, ar- C<sub>1</sub>-C<sub>6</sub>-alkyl or C<sub>1</sub>-C<sub>6</sub>-alkyl.

5                   126. The compound according to claim 123 wherein said halo group is fluoro.

                  127. The compound according to claim 123 wherein g is zero.

10

                  128. A pharmaceutical composition that comprises a compound according to claim 52 dissolved or dispersed in a pharmaceutically acceptable carrier.

15

                  129. A pharmaceutical composition that comprises a compound according to claim 62 dissolved or dispersed in a pharmaceutically acceptable carrier.

20

                  130. A pharmaceutical composition that comprises a compound according to claim 69 dissolved or dispersed in a pharmaceutically acceptable carrier.

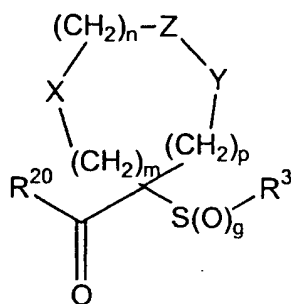
25

                  131. A pharmaceutical composition that comprises a compound according to claim 87 dissolved or dispersed in a pharmaceutically acceptable carrier.

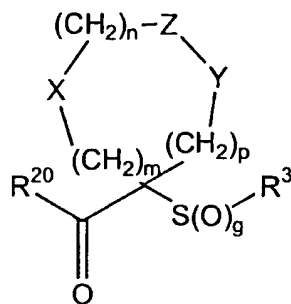
30

                  132. A process for forming a metalloprotease inhibitor compound product or

intermediate compound product therefore that  
 comprises the step of coupling an intermediate  
 compound with another moiety, wherein said  
 intermediate compound corresponds in structure to  
 5 formula VIB, below, and said product corresponds in  
 structure to formula VIA, below:



VIA



VIB

wherein

10 g is zero, 1 or 2;

R<sup>3'</sup> is an aryl or heteroaryl group that is  
 substituted with a coupling substituent reactive for  
 coupling with another moiety ;

R<sup>3</sup> is an optionally substituted aryl or  
 15 optionally substituted heteroaryl radical, and when  
 said aryl or heteroaryl radical is substituted, the  
 substituent is (a) selected from the group consisting  
 of an optionally substituted cycloalkyl,  
 heterocycloalkyl, aryl, heteroaryl, aralkyl,  
 20 heteroaralkyl, aralkoxy, heteroaralkoxy,  
 aralkoxyalkyl, aryloxyalkyl, aralkanoylalkyl,  
 arylcarbonylalkyl, aralkylaryl, aryloxyalkylaryl,  
 aralkoxyaryl, arylazoaryl, arylhydrazinoaryl,  
 alkylthioaryl, arylthioalkyl, alkylthioaralkyl,  
 25 aralkylthioalkyl, an aralkylthioaryl radical, the  
 sulfoxide or sulfone of any of the thio substituents,

and a fused ring structure comprising two or more 5- or 6-membered rings selected from the group consisting of aryl, heteroaryl, cycloalkyl and heterocycloalkyl, and (b) is itself optionally substituted with one or more substituents independently selected from the group consisting of a cyano, perfluoroalkyl, trifluoromethoxy, trifluoromethylthio, haloalkyl, trifluoromethylalkyl, aralkoxycarbonyl, aryloxycarbonyl, hydroxy, halo, alkyl, alkoxy, nitro, thiol, hydroxycarbonyl, aryloxy, arylthio, aralkyl, aryl, arylcarbonylamino, heteroaryloxy, heteroarylthio, heteroaralkyl, cycloalkyl, heterocyclooxy, heterocyclothio, heterocycloamino, cycloalkyloxy, cycloalkylthio, heteroaralkoxy, heteroaralkylthio, aralkoxy, aralkylthio, aralkylamino, heterocyclo, heteroaryl, arylazo, hydroxycarbonylalkoxy, alkoxycarbonylalkoxy, alkanoyl, arylcarbonyl, aralkanoyl, alkanoyloxy, aralkanoyloxy, hydroxyalkyl, hydroxyalkoxy, alkylthio, alkoxyalkylthio, alkoxycarbonyl, aryloxyalkoxyaryl, arylthioalkylthioaryl, aryloxyalkylthioaryl, arylthioalkoxyaryl, hydroxycarbonylalkoxy, hydroxycarbonylalkylthio, alkoxycarbonylalkoxy, alkoxycarbonylalkylthio, amino, wherein the amino nitrogen is (i) unsubstituted, or (ii) substituted with one or two substituents that are independently selected from the group consisting of an alkyl, aryl, heteroaryl, aralkyl, cycloalkyl, aralkoxycarbonyl, alkoxycarbonyl, arylcarbonyl, aralkanoyl, heteroarylcarbonyl, heteroaralkanoyl and an alkanoyl group, or (iii) wherein the amino nitrogen and two substituents attached thereto

form a 5- to 8-membered heterocyclo or heteroaryl ring containing zero to two additional heteroatoms that are nitrogen, oxygen or sulfur and which ring itself is (a) unsubstituted or (b) substituted with one or two groups independently selected from the group consisting of an aryl, alkyl, heteroaryl, aralkyl, heteroaralkyl, hydroxy, alkoxy, alkanoyl, cycloalkyl, heterocycloalkyl, alkoxy carbonyl, hydroxyalkyl, trifluoromethyl, benzofused heterocycloalkyl, hydroxyalkoxyalkyl, aralkoxy carbonyl, hydroxycarbonyl, aryloxy carbonyl, benzofused heterocycloalkoxy, benzofused cycloalkyl carbonyl, heterocycloalkyl carbonyl, and a cycloalkyl carbonyl group, carbonylamino wherein the carbonylamino nitrogen is (i) unsubstituted, or (ii) is the reacted amine of an amino acid, or (iii) substituted with one or two radicals selected from the group consisting of an alkyl, hydroxyalkyl, hydroxyheteroaralkyl, cycloalkyl, aralkyl, trifluoromethylalkyl, heterocycloalkyl, benzofused heterocycloalkyl, benzofused heterocycloalkyl, benzofused cycloalkyl, and an N,N-dialkylsubstituted alkylamino-alkyl group, or (iv) the carboxamido nitrogen and two substituents bonded thereto together form a 5- to 8-membered heterocyclo, heteroaryl or benzofused heterocycloalkyl ring that is itself unsubstituted or substituted with one or two radicals independently selected from the group consisting of an alkyl, alkoxy carbonyl, nitro, heterocycloalkyl,

hydroxy, hydroxycarbonyl, aryl, aralkyl,  
heteroaralkyl and an amino group,

wherein the amino nitrogen is

(i) unsubstituted, or (ii) substituted with  
5 one or two substituents that are  
independently selected from the group  
consisting of alkyl, aryl, and heteroaryl,  
or (iii) wherein the amino nitrogen and two  
substituents attached thereto form a 5- to  
10 8-membered heterocyclo or heteroaryl ring,  
and an aminoalkyl group

wherein the aminoalkyl nitrogen is (i)  
unsubstituted, or (ii) substituted with one or two  
substituents independently selected from the group  
15 consisting of an alkyl, aryl, aralkyl, cycloalkyl,  
aralkoxycarbonyl, alkoxycarbonyl, and an alkanoyl  
group, or (iii) wherein the aminoalkyl nitrogen and  
two substituents attached thereto form a 5- to 8-  
membered heterocyclo or heteroaryl ring;

20 m is zero, 1 or 2;

n is zero, 1 or 2;

p is zero, 1 or 2;

the sum of  $m + n + p = 1, 2, 3$  or  $4$ ;

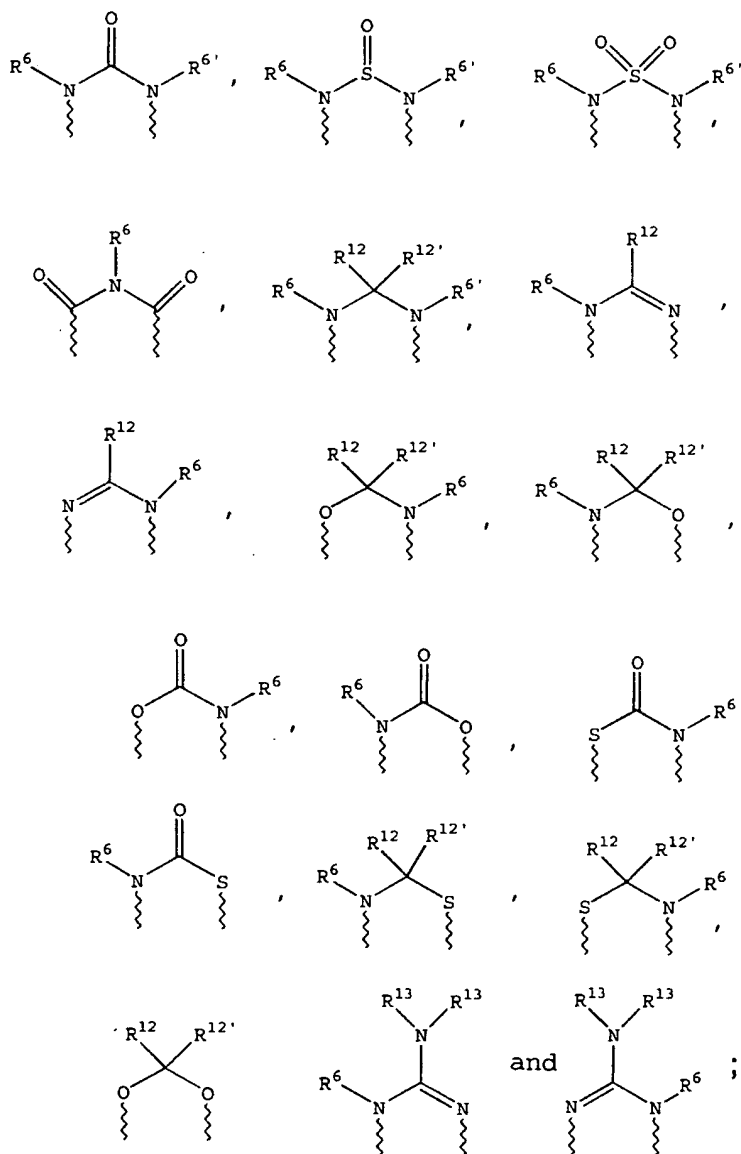
(a) one of X, Y and Z is selected from  
25 the group consisting of  $C(O)$ ,  $NR^6$ , O, S,  $S(O)$ ,  $S(O)_2$   
and  $NS(O)_2R^7$ , and the remaining two of X, Y and Z are  
 $CR^8R^9$ , and  $CR^{10}R^{11}$ , or

(b) X and Z or Z and Y together  
constitute a moiety that is selected from the group  
30 consisting of  $NR^6C(O)$ ,  $NR^6S(O)$ ,  $NR^6S(O)_2$ ,  $NR^6S$ ,  $NR^6O$ ,

-836-

SS,  $\text{NR}^6\text{NR}^6$  and  $\text{OC(O)}$ , with the remaining one of X, Y and Z being  $\text{CR}^8\text{R}^9$ , or

(c) n is zero and X, Y and Z together constitute a moiety selected from the group  
5 consisting of



wherein wavy lines are bonds to the atoms of the depicted ring;

$R^6$  and  $R^{6'}$  are independently selected from the group consisting of hydrido,  $C_1$ - $C_6$ -alkanoyl,  $C_6$ -aryl- $C_1$ - $C_6$ -alkyl, aroyl, bis( $C_1$ - $C_6$ -alkoxy- $C_1$ - $C_6$ -alkyl)- $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_6$ -haloalkyl,  $C_1$ - $C_6$ -perfluoroalkyl,  $C_1$ - $C_6$ -trifluoromethylalkyl,  $C_1$ - $C_6$ -perfluoroalkoxy- $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_6$ -alkoxy- $C_1$ - $C_6$ -alkyl,  $C_3$ - $C_6$ -cycloalkyl,  $C_3$ - $C_8$ -heterocycloalkyl,  $C_3$ - $C_8$ -heterocycloalkylcarbonyl,  $C_6$ -aryl,  $C_5$ - $C_6$ -heterocyclo,  $C_5$ - $C_6$ -heteroaryl,  $C_3$ - $C_8$ -cycloalkyl- $C_1$ - $C_6$ -alkyl,  $C_6$ -aryloxy- $C_1$ - $C_6$ -alkyl, heteroaryloxy- $C_1$ - $C_6$ -alkyl, heteroaryl- $C_1$ - $C_6$ -alkoxy- $C_1$ - $C_6$ -alkyl, heteroarylthio- $C_1$ - $C_6$ -alkyl,  $C_6$ -arylsulfonyl,  $C_1$ - $C_6$ -alkylsulfonyl,  $C_5$ - $C_6$ -heteroarylsulfonyl, carboxy- $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_4$ -alkoxycarbonyl- $C_1$ - $C_6$ -alkyl, aminocarbonyl,  $C_1$ - $C_6$ -alkyliminocarbonyl,  $C_6$ -aryliminocarbonyl,  $C_5$ - $C_6$ -heterocycloiminocarbonyl,  $C_6$ -arylthio- $C_1$ - $C_6$ -alkyl,  $C_1$ - $C_6$ -alkylthio- $C_1$ - $C_6$ -alkyl,  $C_6$ -arylthio- $C_3$ - $C_6$ -alkenyl,  $C_1$ - $C_4$ -alkylthio- $C_3$ - $C_6$ -alkenyl,  $C_5$ - $C_6$ -heteroaryl- $C_1$ - $C_6$ -alkyl, halo- $C_1$ - $C_6$ -alkanoyl, hydroxy- $C_1$ - $C_6$ -alkanoyl, thiol- $C_1$ - $C_6$ -alkanoyl,  $C_3$ - $C_6$ -alkenyl,  $C_3$ - $C_6$ -alkynyl,  $C_1$ - $C_4$ -alkoxy- $C_1$ - $C_4$ -alkyl,  $C_1$ - $C_5$ -alkoxycarbonyl, aryloxycarbonyl,  $NR^8R^9$ - $C_1$ - $C_5$ -alkylcarbonyl, hydroxy- $C_1$ - $C_5$ -alkyl, an aminocarbonyl wherein the aminocarbonyl nitrogen is (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group

consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl and a C<sub>1</sub>-C<sub>6</sub>-alkanoyl group,  
hydroxyaminocarbonyl, an aminosulfonyl group wherein the aminosulfonyl nitrogen is (i) unsubstituted or  
5 (ii) substituted with one or two radicals  
independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl and a C<sub>1</sub>-C<sub>6</sub>-alkanoyl group, an amino-C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl group wherein the amino-C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl nitrogen  
10 is (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl and a C<sub>1</sub>-C<sub>6</sub>-alkanoyl group and an amino-C<sub>1</sub>-C<sub>6</sub>-alkyl group wherein the aminoalkyl nitrogen is  
15 (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>8</sub>-cycloalkyl and a C<sub>1</sub>-C<sub>6</sub>-alkanoyl group;

R<sup>7</sup> is selected from the group consisting of  
20 a arylalkyl, aryl, heteroaryl, heterocyclo, C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>3</sub>-C<sub>6</sub>-alkynyl, C<sub>3</sub>-C<sub>6</sub>-alkenyl, C<sub>1</sub>-C<sub>6</sub>-carboxyalkyl and a C<sub>1</sub>-C<sub>6</sub>-hydroxyalkyl group;

R<sup>8</sup> and R<sup>9</sup> and R<sup>10</sup> and R<sup>11</sup> are independently selected from the group consisting of a hydrido,  
25 hydroxy, C<sub>1</sub>-C<sub>6</sub>-alkyl, aryl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryl, heteroar-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>2</sub>-C<sub>6</sub>-alkynyl, C<sub>2</sub>-C<sub>6</sub>-alkenyl, thiol-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl cycloalkyl, cycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, heterocycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-



alkyl, aralkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxycarbonyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxycarbonylar-C<sub>1</sub>-C<sub>6</sub>-alkyl, aminocarbonyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, aryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, arylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroarylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, the sulfoxide or sulfone of any said thio substituents, perfluoro-C<sub>1</sub>-C<sub>6</sub>-alkyl, trifluoromethyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, halo-C<sub>1</sub>-C<sub>6</sub>-alkyl, alkoxycarbonylamino-C<sub>1</sub>-C<sub>6</sub>-alkyl and an amino-C<sub>1</sub>-C<sub>6</sub>-alkyl group wherein the aminoalkyl nitrogen is (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, cycloalkyl and C<sub>1</sub>-C<sub>6</sub>-alkanoyl, or wherein R<sup>8</sup> and R<sup>9</sup> or R<sup>10</sup> and R<sup>11</sup> and the carbon to which they are bonded form a carbonyl group, or wherein R<sup>8</sup> and R<sup>9</sup> or R<sup>10</sup> and R<sup>11</sup>, or R<sup>8</sup> and R<sup>10</sup> together with the atoms to which they are bonded form a 5- to 8-membered carbocyclic ring, or a 5- to 8-membered heterocyclic ring containing one or two heteroatoms that are nitrogen, oxygen, or sulfur, with the proviso that only one of R<sup>8</sup> and R<sup>9</sup> or R<sup>10</sup> and R<sup>11</sup> is hydroxy;

R<sup>12</sup> and R<sup>12'</sup> are independently selected from the group consisting of a hydrido, C<sub>1</sub>-C<sub>6</sub>-alkyl, aryl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryl, heteroaralkyl, C<sub>2</sub>-C<sub>6</sub>-alkynyl, C<sub>2</sub>-C<sub>6</sub>-alkenyl, thiol-C<sub>1</sub>-C<sub>6</sub>-alkyl, cycloalkyl, cycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, heterocycloalkyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, aryloxy-C<sub>1</sub>-C<sub>6</sub>-

- alkyl, amino-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxycarbonyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, hydroxycarbonylar-C<sub>1</sub>-C<sub>6</sub>-alkyl, aminocarbonyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, aryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroaryloxy-C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>1</sub>-C<sub>6</sub>-alkylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, arylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, heteroarylthio-C<sub>1</sub>-C<sub>6</sub>-alkyl, the sulfoxide or sulfone of any said thio substituents, perfluoro-C<sub>1</sub>-C<sub>6</sub>-alkyl, trifluoromethyl-C<sub>1</sub>-C<sub>6</sub>-alkyl, halo-C<sub>1</sub>-C<sub>6</sub>-alkyl, alkoxycarbonylamino-C<sub>1</sub>-C<sub>6</sub>-alkyl and an amino-C<sub>1</sub>-C<sub>6</sub>-alkyl group wherein the aminoalkyl nitrogen is (i) unsubstituted or (ii) substituted with one or two radicals independently selected from the group consisting of C<sub>1</sub>-C<sub>6</sub>-alkyl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl, cycloalkyl and C<sub>1</sub>-C<sub>6</sub>-alkanoyl;
- 15                   R<sup>13</sup> is selected from the group consisting of a hydrido, benzyl, phenyl, C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>2</sub>-C<sub>6</sub>-alkynyl, C<sub>2</sub>-C<sub>6</sub>-alkenyl and a C<sub>1</sub>-C<sub>6</sub>-hydroxyalkyl group; and
- 20                   R<sup>20</sup> is (a) -O-R<sup>21</sup>, wherein R<sup>21</sup> is selected from the group consisting of a hydrido, C<sub>1</sub>-C<sub>6</sub>-alkyl, aryl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl group and a pharmaceutically acceptable cation, (b) -NH-O-R<sup>22</sup>, wherein R<sup>22</sup> is a selectively removable protecting group such as a 2-tetrahydropyranyl, benzyl, p-methoxybenzyl, carbonyl-C<sub>1</sub>-C<sub>6</sub>-alkoxy, trisubstituted silyl group, an o-nitrophenyl group, and a peptide synthesis resin, wherein the trisubstituted silyl group is substituted with C<sub>1</sub>-C<sub>6</sub>-alkyl, aryl, or ar-C<sub>1</sub>-C<sub>6</sub>-alkyl or a mixture thereof, (c) -NH-O-R<sup>14</sup>, where R<sup>14</sup> is hydrido,
- 25

a pharmaceutically acceptable cation or  $C(W)R^{25}$  where W is O or S and  $R^{25}$  is selected from the group consisting of an  $C_1-C_6$ -alkyl, aryl,  $C_1-C_6$ -alkoxy, heteroaryl- $C_1-C_6$ -alkyl,  $C_3-C_8$ -cycloalkyl- $C_1-C_6$ -alkyl, 5 aryloxy, ar- $C_1-C_6$ -alkoxy, ar- $C_1-C_6$ -alkyl, heteroaryl and amino  $C_1-C_6$ -alkyl group wherein the amino  $C_1-C_6$ -alkyl nitrogen is (i) unsubstituted or (ii) substituted with one or two substituents independently selected from the group consisting of 10 an  $C_1-C_6$ -alkyl, aryl, ar- $C_1-C_6$ -alkyl,  $C_3-C_8$ -cycloalkyl- $C_1-C_6$ -alkyl, ar- $C_1-C_6$ -alkoxycarbonyl,  $C_1-C_6$ -alkoxycarbonyl, and  $C_1-C_6$ -alkanoyl radical, or (iii) wherein the amino  $C_1-C_6$ -alkyl nitrogen and two substituents attached thereto form a 5- to 8-membered 15 heterocyclo or heteroaryl ring, or (d)  $-NR^{26}R^{27}$ , where  $R^{26}$  and  $R^{27}$  are independently selected from the group consisting of a hydrido,  $C_1-C_6$ -alkyl, amino  $C_1-C_6$ -alkyl, hydroxy  $C_1-C_6$ -alkyl, aryl, ar- $C_1-C_6$ -alkyl group, or  $R^{26}$  and  $R^{27}$  together with the depicted 20 nitrogen atom form a 5- to 8-membered ring containing zero or one additional heteroatom that is oxygen, nitrogen or sulfur.

133. The process according to claim 132 25 including the further step of recovering said product.

134. The process according to claim 132 wherein  $R^{20}$  is  $-NH-O-R^{22}$ , wherein  $R^{22}$  is a 30 selectively removable protecting group.

135. The process according to claim 134 wherein said selectively removable protecting group is selected from the group consisting of a 2-  
5 tetrahydropyranyl, benzyl, p-methoxybenzyloxycarbonyl, benzyloxycarbonyl, C<sub>1</sub>-C<sub>6</sub>-alkoxycarbonyl, C<sub>1</sub>-C<sub>6</sub>-alkoxy-CH<sub>2</sub>- , C<sub>1</sub>-C<sub>6</sub>-alkoxy-C<sub>1</sub>-C<sub>6</sub>-alkoxy-CH<sub>2</sub>- , an o-nitrophenyl group and a peptide synthesis resin.

10

136. The process according to claim 132 wherein said coupling substituent is a nucleophilically displaceable leaving group

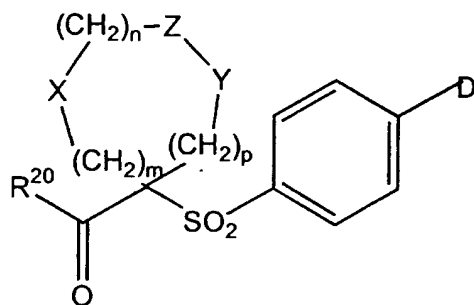
15 137. The process according to claim 132 wherein said nucleophilically displaceable leaving group is selected from the group consisting of a halo, nitro, azido, phenylsulfoxido, aryloxy, C<sub>1</sub>-C<sub>6</sub>-alkoxy, a C<sub>1</sub>-C<sub>6</sub>-alkylsulfonate or arylsulfonate group  
20 and a trisubstituted ammonium group in which the three substituents are independently aryl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl or C<sub>1</sub>-C<sub>6</sub>-alkyl.

138. The process according to claim 132  
25 wherein g is 2.

139. The process according to claim 132 wherein said R<sup>3</sup> is an aryl or heteroaryl group.

30 140. The process according to claim 132 wherein said intermediate that corresponds in

structure to formula VI corresponds in structure to formula VIIA, below,



VIIA

5                    wherein D is said nucleophilically  
displaceable leaving group and is selected from the  
group consisting of a halo, nitro, azido,  
phenylsulfoxido, aryloxy, C<sub>1</sub>-C<sub>6</sub>-alkoxy, a C<sub>1</sub>-C<sub>6</sub>-  
alkylsulfonate or arylsulfonate group and a  
10 trisubstituted ammonium group in which the three  
substituents are independently aryl, ar-C<sub>1</sub>-C<sub>6</sub>-alkyl  
or C<sub>1</sub>-C<sub>6</sub>-alkyl.

141. The process according to claim 132  
15 including the further step of recovering said  
product.

142. The process according to claim 132  
including the further step of selectively removing  
20 said protecting group, R<sup>22</sup>.

143. The process according to claim 142  
wherein said protecting group, R<sup>22</sup>, is removed after  
carrying out the further step of recovering said  
25 product.

144. The process according to claim 143 wherein said protecting group,  $R^{22}$ , is a 2-tetrahydropyranyl group.

5

145. The process according to claim 133 wherein  $R^{21}$  in said product after recovery is hydrido, and including the further step of reacting said product with hydroxyl amine or a hydroxyl amine  
10 whose oxygen is reacted with a selectively removable protecting group selected from the group consisting of a 2-tetrahydropyranyl,  $C_1$ - $C_6$ -acyl, aroyl, benzyl, p-methoxybenzyloxycarbonyl, benzyloxycarbonyl,  $C_1$ - $C_6$ -alkoxycarbonyl,  $C_1$ - $C_6$ -alkoxy- $CH_2$ -,  $C_1$ - $C_6$ -alkoxy- $C_1$ -  
15  $C_6$ -alkoxy- $CH_2$ -, an o-nitrophenyl group and a peptide synthesis resin to form a hydroxamic acid or protected hydroxamate product.

146. The process according to claim 145  
20 including the further step of recovering the product formed.

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 00/02518

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 C07D211/66 C07C317/44 A61K31/445 C07D211/94 A61K31/35  
A61K31/16 C07D239/04 C07D309/08 C07D335/02 C07D401/06  
C07D405/12 C07D409/12 C07D417/12

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 C07D C07C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	WO 99 42436 A (AMERICAN CYANAMID CO) 26 August 1999 (1999-08-26)	1-146
P,Y	see the whole application, examples and claims	1-146
P,X	WO 99 25687 A (CRESCENZO GARY A DE ;MCDONALD JOSEPH J (US); BOEHM TERRI L (US); S) 27 May 1999 (1999-05-27)	1-146
P,Y	see whole document	1-146
X	WO 98 37877 A (AMERICAN CYANAMID CO) 3 September 1998 (1998-09-03)	1-146
Y	the whole document	1-146
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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

\* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

19 June 2000

Date of mailing of the international search report

29.06.00

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Scruton-Evans, I

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 00/02518

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 98 38163 A (AMERICAN CYANAMID CO) 3 September 1998 (1998-09-03)	1-6
Y	the whole document	1-146
Y	EP 0 780 386 A (HOFFMANN LA ROCHE ; AGOURON PHARMA (US)) 25 June 1997 (1997-06-25) cited in the application the whole document	1-146
Y	WO 97 24117 A (RHONE POULENC RORER PHARMA ; GRONEBERG ROBERT D (US); NEUENSCHWANDE) 10 July 1997 (1997-07-10) cited in the application the whole document	1-146
X	EP 0 266 182 A (TAKEDA CHEMICAL INDUSTRIES LTD) 4 May 1988 (1988-05-04)  see page 19, claim 1, page 10, examples 9-11, page 15, examples 35, 38 the whole document	105, 118-123, 125-127



# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US 00/02518

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☒ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:  
  
Although claims 1-51 are directed to a method of treatment of the human/animal body, the search has been carried out and based on the alleged effects of the compound/composition.
2. ☒ Claims Nos.: 105-124, 126, 127  
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:  
  
see FURTHER INFORMATION sheet PCT/ISA/210
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box I.2

Claims Nos.: 105-124,126,127

The novelty search on the compounds of the formula VI according to claim 105 wherein R20 is O-R21 revealed a vast amount of novelty destroying documents. In the case of said esters, the International Search Report has been limited to the intermediates of formula VII according to claim 123, wherein the D group is defined according to claim 125.

The applicant's attention is drawn to the fact that claims, or parts of claims, relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure.

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 00/02518

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
WO 9942436	A	26-08-1999	AU 9120198	A	06-09-1999
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